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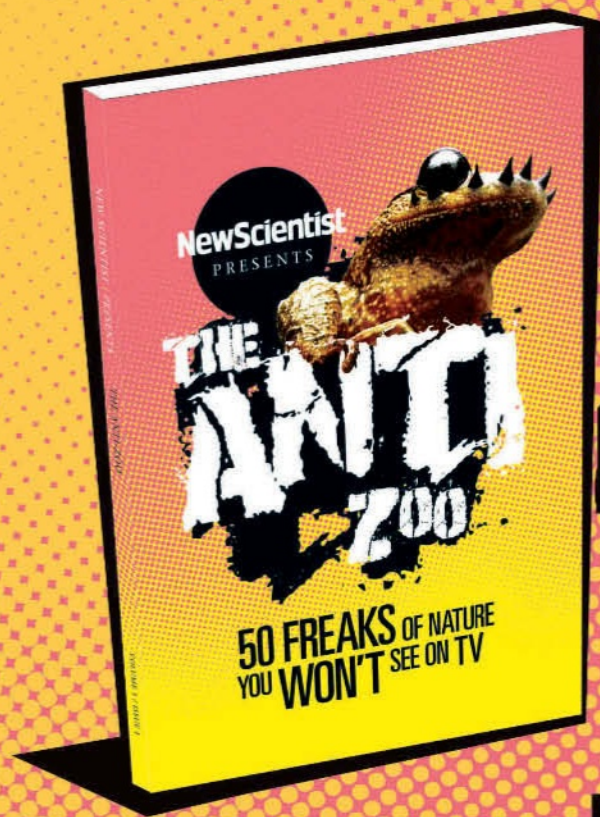


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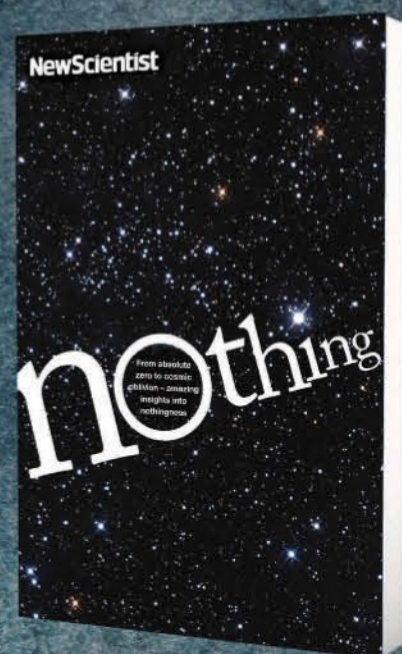
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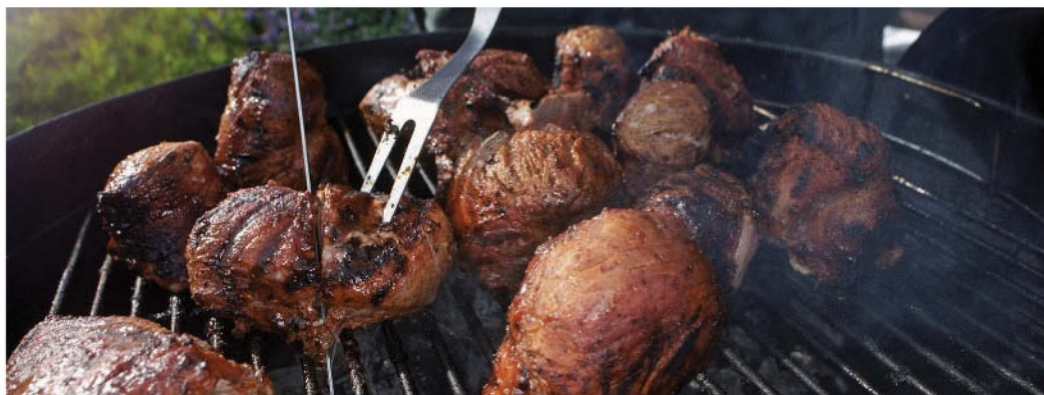
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MIKAEL ANDERSSON/PLANET PICTURE

The real cost of meat

If health issues don't move you, how about the environment?

NOT long ago, a meal centred on meat was a rare treat. No longer. Most of us in the West now eat meat every day; many consume it at every meal. And people in less carnivorous cultures are getting a taste for it, too: in China it has become aspirational. Worldwide meat production has surged from 78 million tonnes per year in 1963 to 308 million tonnes in 2014.

The problem, setting aside issues around the morality of eating animals, is that the planet cannot support this growing appetite. Pasture used to graze livestock already accounts for 26 per cent of the planet's ice-free landmass; the meat industry is responsible for 15 per cent of all greenhouse gas emissions.

There is a strong case that meat is now too cheap, its price pushed down by ever more intensive farming practices. While that is ostensibly good for consumers, it's bad for the environment – in terms of pollution and antibiotic resistance, as well as climate – and very often bad for animals. And it can be bad for consumers if corners are cut to keep prices low (16 February 2013, p 6).

Is it possible to push the price back up? Governments have succeeded in reducing the consumption of alcohol and tobacco by taxing them. But a "sin tax" on meat lacks the clear case established for drinking and smoking: there is mixed evidence on potential links between high

levels of meat consumption, cancer and heart disease. And it depends on exactly what you eat (see page 30). A more viable option might be to pull back on the agricultural subsidies that underpin meat production.

Persuasion may work better than coercion. In the UK and US, health concerns have already reduced consumption of red and processed meat. Later this month, the US Department of Agriculture will issue its latest dietary guidelines. This time, the recommendations may address effects on the environment as well as health. The industry won't like it, but the public may find that a lower-meat diet is more to its taste. ■

Sellafield's long haul

THERE are few engineering challenges more difficult than decommissioning nuclear infrastructure. And there are few decommissioning challenges more difficult than Sellafield. Cradle of the UK's nuclear programme – and site of the 1957 Windscale fire, the world's first major nuclear power accident – it is a cramped old site inhabited by 10,000 workers (see page 8).

The UK government is doing some things right in its bid to clean up Sellafield. Not least, it is finally funding research into the site's unique and complex problems. Inevitably, that turns up new problems, increasing the bill and setting back the timetable.

The temptation then is to sack the managers and install a new lot: in 2008, a Labour government privatised the clean-up; last week,

the Coalition renationalised it. But changes at the top won't fix the basic problem.

Half a century ago, the UK was rushing to build its nuclear deterrent and generate electricity. Short-termism then means we are in for the long haul now: the clean-up plan runs all the way to 2120. And you shouldn't bet against that slipping further as unwelcome surprises inevitably crop up. Despite the assurances of whoever is at its helm, this one will run and run. And run. ■



Watery link to Boko Haram

COULD a shrinking lake in West Africa have helped foster a ruthless Islamist group? And if so, would restoring the lake help peg it back?

Media reports in the past few days have floated the idea that poverty caused by the shrinkage of Lake Chad has fuelled support for Boko Haram, the Islamist group entrenched in parts of north-east Nigeria. Refilling the lake via a grandiose canal scheme called Transaqua would blunt the group's influence, they suggest.

Lake Chad, bordering Nigeria, Niger, Chad and Cameroon, has shrunk by 90 per cent in just 50 years owing to poor rains and drainage for irrigation. That has destroyed fishing villages and left desperate communities prey to lawlessness and religious extremism.

Research has linked the likelihood

of conflict to drought and other long-term extremes of weather, but the results are controversial. Researchers contacted by *New Scientist* broadly backed the link, but say poverty triggered by environmental change plays a minor role compared with other factors, such as the spread of extreme religious ideology.

Halvard Buhaug of the Peace Research Institute in Oslo, Norway, is sceptical about a direct link between drought and insurgency. "But that doesn't rule out the possibility of a causal connection in individual cases, even if only by creating a window of opportunity for activists to mobilise others for their cause," he says.

"There's no doubt the environmental situation around Lake Chad is very challenging, with massive

desert encroachment that clearly impacts on livelihoods," says Ukoha Ukiwo of the Nigeria Stability and Reconciliation Programme, in Abuja. But he says there is not much evidence linking the lake's state with the insurgency.

The Lake Chad Basin Commission, based in N'Djamena, Chad, wants to reroute 100 billion cubic metres of water per year from the Congo river, sending it via a 2400-kilometre canal into the Chari river, one of Lake Chad's tributaries. That could help make communities less prone to siding with terrorists, but there is no one solution to the problem, says Ukiwo. Besides, he says, the area is too insecure for the scheme to go ahead. "If you sent engineers there now, Boko Haram would just kidnap them and get more resources by ransoming them."

Civilisation's risks

NO BIGGIE. World leaders are in Davos this week to discuss risks to our very civilisation.

The World Economic Forum's (WEF) annual meeting looks for solutions to global risks, and this year environmental problems are expected to get more attention.

"The risks of the last 10 years were all about economy. Those in the next 10 will be about societal and environmental issues," said Axel Lehmann of Zurich Insurance, at the launch last week of a WEF report that polled the opinions of 900 experts, including researchers, politicians and business leaders.

The report concludes that past warnings of environmental

"The last 10 years were all about economy. The risks in the next 10 years will be environmental"

catastrophes have begun to be borne out, and criticises a lack of action on climate change and the growing demand for limited freshwater resources.

The meeting comes just days after 2014 was declared globally the hottest year on record. But not adapting to climate change came only fifth on the report's list of risks to humankind. Water shortages and pandemics ranked top.

Beagle had landed!

BEAGLE 2, the UK spacecraft thought lost on Mars in 2003, has been found. It seems the probe landed successfully but did not fully deploy its solar panels, so could not communicate with Earth. But the spacecraft may have scientific data stored in its memory that astronauts could one day retrieve.

The Beagle 2 team spotted the missing lander in images taken recently by NASA's Mars Reconnaissance Orbiter. The probe

was deployed to the Martian surface on Christmas day 2003 from the European Space Agency's Mars Express spacecraft. It was equipped with a parachute to slow its descent and air bags to soften the landing, but when no signal came, the team assumed it had crashed.

Beagle 2 unfolded up to three of its four solar panels, the team believes. Unfortunately, its radio antenna was hidden below a faulty panel, so it could not transmit. The discovery means the UK can now officially claim to have landed on Mars, joining only the US and the then Soviet Union.

The S word

GO ON, say it. Say "suicide", and you just might save someone's life, not push them to end it. The move to destigmatise the word is central to a "zero suicides" campaign, launched this week by UK deputy prime minister Nick Clegg, to cut deaths in people treated by the country's National Health Service.

The goal is to emulate the impressive results from a decade-long anti-suicide programme pioneered in Detroit, Michigan, by the Henry Ford Health System. Within four years of the programme launching in 2001, suicides dropped 75 per cent, from 89 to 22 patients per 100,000 of the population covered. And between 2008 and 2010, there were no suicides at all.

One factor in Detroit's success has been the strategy of openly talking about suicide at all stages of a person's mental illness, says Sarah Hughes of UK charity MIND, which since September has run one of three pilot projects in the UK pursuing the zero suicides goal. "The assumption has always been that if you mention suicide, people will do it, but the Detroit model shows the complete opposite," she says.

"Breaking the taboo is the biggest thing for us," says Hughes.

Obesity implant

FROM stomach-stapling to jaw-wiring, some of the ways to fight obesity are certainly dramatic. Soon an implant may be on the menu. The Maestro Rechargeable System has been approved by the US Food and Drug Administration for people who are severely obese and have a related condition such as diabetes.

It is claimed to block signals travelling along the vagus nerve between the stomach and brain, reducing hunger. Once fitted, it is adjusted wirelessly. It is due to go on sale in the US this year.

The device leads to only modest weight loss – about 9 per cent. "That's not a game changer," says Nick Finer of University College Hospital in London.

More weight is shed after gastric bypass surgery, but Scott Shikora,

"The device is an alternative to gastric bypass surgery that doesn't involve replumbing the intestines"

a surgeon and consultant for the device's maker, EnteroMedics in St Paul, Minnesota, says that some people dislike the idea of "replumbing" their intestines.

Ukraine healthcare in crisis

CONFLICT doesn't just harm people – it also damages systems that could make them better. Separatist unrest in Ukraine has left the country struggling with TB and at risk of outbreaks of polio and measles, the World Health Organization warns.

The WHO says that between 30 and 70 per cent of health workers in eastern Ukraine are dead or have fled, and that at least \$23 million is needed to provide improved healthcare for the region's 5 million inhabitants. Some 1.4 million people are particularly vulnerable, in part because they have pre-existing conditions or have had to leave their homes, it said in a note published on 16 January. People with HIV or AIDS in the Donbas region, which

includes the cities of Donetsk and Luhansk, face possible interruptions to their therapy.

Patients themselves have to foot the bill for almost half of Ukraine's healthcare costs, says Kateryna Onishchenko, a health economist at Swansea University, UK, who is originally from Donetsk. "Due to the situation in the Donbas area, access to healthcare services has worsened, as some people are unable to pay for their medical services," she says, adding that destroyed supply chains are also hampering care.

Water and power supplies have broken down in Donetsk and Luhansk, and many of the region's healthcare facilities have been damaged by fighting or looting.

ANTONIO BRONIC/REUTERS/CORBIS



Wards are gravely understaffed

60 SECONDS

Prospecting for drugs

Citizen scientists on five continents are helping to map the biochemical richness of soil around the world, looking for bacteria that could be used as antibiotics. The Drugs from Dirt project is already paying off – an area in New Mexico and an Atlantic forest region in Brazil have already been identified as hotspots.

Sweating it

Last year was the warmest on record, with global temperatures 0.69°C above the 20th-century average. Nine of the 10 warmest years on record have occurred since 2000. Visit our interactive graphic of Earth's rising temperatures at bit.ly/NSwarming to find out more.

Flying visit

A half-kilometre-wide asteroid will safely pass by us on 26 January, coming within three times the distance from Earth to the moon. The space rock, designated 2004 BL86, is expected to be the closest-approaching asteroid of this size until 2027.

Neonatal milestone

A newborn baby girl who died six days after birth has become the UK's first "baby donor". Her 5-centimetre-long kidneys went to a patient with renal failure and some liver cells went to another recipient. Doctors haven't disclosed any more about the recipients, but said such tiny organs could be donated to another baby or even an adult (*Archives of Disease in Childhood*, doi.org/zj8).

Scary people

Pumas seem to hunt more – but eat less – when they live near human developments. They consume 40 per cent less meat because they abandon kills earlier, and must hunt more as a result. This might be a result of pumas fearing nearby people and could be costing them time and energy (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2014.2711).

New delays hit Sellafield clean-up

Fred Pearce looks at what went wrong at one of the world's riskiest nuclear waste sites

URGENT clean-up of two of the world's most dangerous radioactive waste stores will be delayed by at least five years, despite growing safety fears.

The waste is stored at the UK's Sellafield nuclear reprocessing site, which holds radioactive waste dating back to the dawn of the nuclear age. An accident at the derelict site could release radioactive materials into the air over the UK and beyond.

Last week, the UK government sacked the private consortium running the £80-billion programme to clean up Sellafield, and gave the job back to its own agency, the Nuclear Decommissioning Authority (NDA). The clean-up operation, scheduled to end by 2120, costs the government £1.9 billion a year.

The private consortium, Nuclear Management Partners, was meant to "bring in world-class

expertise" and allow the government to "get to grips with the legacy after decades of inaction", according to a 2008 statement by Mike O'Brien, energy minister at the time. But six years on, the privatisation experiment has been abandoned.

The surprise renationalisation comes after delays at two of the four waste stores prioritised for clean-up. The four ponds and silos contain hundreds of tonnes of

highly radioactive material from more than 60 years of operations. The decaying structures are cracking, leaking waste into the soil, and are at risk of explosions from gases created by corrosion.

In an NDA business plan published last April, the emptying of the 100-metre Pile fuel storage pond, which holds used fuel and waste from the manufacture of the first UK nuclear bombs in the 1950s and 60s, was planned to be



DANGER AREAS

Pile 1 is one of the two original reactors built to support the UK atomic bomb project. It is where the country's worst nuclear accident took place, when the reactor core caught fire in 1957. Once the fire was extinguished the core was sealed and it is considered best left alone for now.

Pile fuel storage pond took in spent fuel from both the weapons reactors and energy reactors. The radioactive waste and sludge formed from the storage process sit in a deteriorating concrete structure filled with water. Removal of the sludge is under way. This pond has sat unused since the 1970s.

Pile fuel cladding silo is jammed with 3200 cubic metres of aluminium cladding, which surrounds the fuel rods, much of it from 1950s weapons reactors. It has been sealed since the mid-1960s but corrosion means there is a risk that hydrogen will form, which could lead to explosions.

Magnox spent fuel storage pond is considered the most dangerous industrial building in Europe. The 150-metre-long open-air pond is visited by birds and cracks have caused radioactive material to leak into the soil. No one knows exactly what's in there, but it may contain a tonne of plutonium.

Magnox swarf storage silo is considered the second most dangerous industrial building in Europe. It stores waste magnesium fuel cladding under water. Some sludge has leaked through cracks in the concrete, and there is a risk of explosion from hydrogen released by corrosion of storage vessels.

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completed by 2025. But a timeline in a new draft plan circulated for consultation in December shows the job won't be done until 2030. Likewise, the £750-million task of emptying the 21-metre-high Pile fuel cladding silo, which has been full since 1964, is now scheduled for completion in 2029, not 2024.

Confirming the change, an NDA spokesman told *New Scientist*: "Given the unique technical challenges and complexities of these plants, which were built with no thought to how they would be decommissioned... there will continue to be programme uncertainties."

Sellafield was built on Cumbria's coast in north-west

England in the late 1940s to manufacture plutonium for the UK atomic bomb. The site also housed the world's first commercial nuclear power station, and became a centre for storing highly radioactive waste from reactors.

Most of the highly radioactive waste was dumped into ponds, each several times the size of an Olympic pool. Constantly circulating water kept the waste cool, but also created hundreds of cubic metres of sludge from the corrosion of the metal cladding surrounding the fuel rods.

As a result, the exact contents of the ponds are unclear, says Paul Howarth, managing director of the government-owned National Nuclear Laboratory at Sellafield. "We have to do a lot of R&D just to characterise the inventory, before we can work out how to retrieve the materials."

And the problem is just going to get worse. When plants are decommissioned in the future, waste will still be sent to Sellafield. The UK's plants are mostly made of concrete, rather than steel, which makes them harder to dismantle, says Timothy Abram at the University of Manchester. It also means they create about 30 times more radioactive material. And with a new nuclear plant about to be built at Hinkley Point in Somerset, the amount of radioactive waste headed for Sellafield may grow.

Another unique legacy is the 90,000 tonnes of radioactive graphite stored there, used as fuel cladding. Irradiated graphite accumulates energy known as Wigner energy, which caused the UK's worst nuclear accident in 1957. Researchers are still unsure how to make it safe for disposal.

While other Western nations have policies for dismantling old nuclear plants as soon as they can, the UK plans to mothball them for a century or more first. Nobody wants more radioactive waste until they have cleaned up what is already there. ■



Sellafield holds radioactive waste dating back to the dawn of the nuclear age



Dig that reverb

Ancient echoes speak to us from the big bang

HEAR that? Echoes bouncing around the universe might be carrying messages from shortly after the big bang.

The earliest light in the universe is more than 13 billion years old, its photons dating back to an era when plasma generated in the big bang cooled enough to let light through. These photons carry information about the state of the early universe, but have been growing ever fainter. Now they form the cosmic microwave

"They imagined someone in the early universe sending a message of 0s and 1s into the distant future"

background, a low-level sea of radiation permeating the universe.

Eduardo Martín-Martínez of the University of Waterloo in Ontario, Canada, and his colleagues think they have found another, better-preserved source of clues about the very early universe. They calculated that events which produce photons - such as an atom releasing energy - also create certain echoes in the electromagnetic field, the very field which forms the basis of light.

To test how these could carry

information, the team imagined someone in the early universe sending a message into the distant future by creating a series of echoes and using them to encode a string of 0s and 1s. These echoes travel slower than light but do not fade, meaning they can carry more information than photons over large distances (arxiv.org/abs/1501.01650).

"We prove how an intelligent entity can use this phenomenon to transmit much more information than just plainly sending a radio signal," says Martín-Martínez. Of course, it's pretty unlikely that intelligent aliens from the distant past are trying to signal us in this way, but the principle means it could be worthwhile for cosmologists to look out for these echoes.

"Information about background signals from the early universe will also be propagated through this echo," he says. The challenge is to figure out precisely what form the echoes will take and how to build receivers that can pick them up.

Avi Loeb of Harvard University says it's an interesting idea, but still quite theoretical. "The authors need to give specific examples of observables that would show their effect," he says. Jacob Aron ■

Do you have a healthy personality?

Linda Geddes

OUR personality literally shapes our world. It helps determine how many friends we have, which jobs we excel in and how we cope with adversity. Now it seems it may even play a role in our health – and not just in terms of any hypochondriac tendencies we harbour, but also how prone our bodies are to getting sick in the first place. It is a provocative idea but one that has been steadily gaining traction.

We think of conscientiousness, for example, as a positive trait because it suggests caution, careful planning and an aversion to potential danger. But could it also be a symptom of underlying weakness in the immune system?

That's one interpretation of a study published last month that sought to pick apart the links between personality traits and the immune system. It found that highly conscientious people had lower levels of inflammation; an immune response that helps the body fight infection and recover from injury. Highly extrovert people had higher levels.

This may mean that extroverts are more physically robust – at least while they're young. While this sounds like good news, there's also a downside since sustained inflammation over a lifetime may leave you vulnerable to diabetes, atherosclerosis and cancer.

"The biggest take-home message is that what happens in our health is connected to what happens in our heads and what happens in our lives," says Steven Cole at the University of California in Los Angeles (UCLA), who supervised the research. Although it is difficult to change people's personalities, an understanding of how they influence our

susceptibility to disease might lead to treatments that could boost the immune system in certain personality types. This might be through drugs, or teaching people to manage risky behaviours and adopt healthier ones. An extrovert might adopt a more altruistic outlook on life, for instance, since happiness that comes from having a deep sense of purpose has been shown to reduce inflammation.

Big five

Past studies have hinted at a link between personality and the immune system. However, the current one is the first to assess personality across a range of people, and connect it to the activity of a suite of genes that control how the immune system works. "They are looking at the immune system in a much more cohesive and comprehensive way," says Carmine Pariante, professor of biological psychiatry at King's College London.

In the latest study, Kavita Vedhara at the University of Nottingham, UK, and her colleagues had 121 healthy students fill in personality questionnaires to assess the so-called big five personality traits – conscientiousness, extraversion, neuroticism, openness and agreeableness. They also asked them about other behaviours such as smoking, drinking or exercise that might be associated with certain personality types. They took blood samples to assess the activity of 19 genes involved in the inflammatory response, as well as genes involved in the production of antibodies and viral defence.

Even after controlling for behaviour such as alcohol



consumption, they found that on average, the genes that trigger inflammation are 17 per cent more active in extroverts than in introverts. In students who scored high for conscientiousness the activation of these genes was 16 per cent lower compared with less conscientious people. There was no apparent difference in the other immune system genes (*Psychoneuroendocrinology*, doi.org/zh7).

"What happens in our health is connected to what happens in our heads and what happens in our lives"

"The idea that a huge amount of who and what we are is influenced by the way our species fights disease is a powerful and emerging theme across lots of different areas," says Daniel Davies, an immunologist at the University of Manchester, UK. "A link with personality is not outside the world of what should be looked at," he adds. However, he cautions that it will take more work to confirm the extraversion, conscientiousness and inflammation link. And if it does exist, do the observed differences translate into meaningful differences in health?



Steering clear of infection

Assuming it does hold, the next question is whether the immune system shapes personality, or vice versa. We know that factors such as stress can boost the activity of inflammatory genes, triggering a short-term boost against infection. Conscientious people might have less inflammation simply because they take better care of themselves than extroverts do – so are less likely to get injured or be around other sick people who could potentially pass on germs. It would be a terrific idea to boost inflammation genes if you're running around meeting new people, says Cole.

However, it's also becoming clear that the immune system can influence your mood. A good example of this is "sickness behaviour"; the tendency to become lethargic and withdrawn in response to infection. Possibly, it's a two-way street. "The mechanisms don't have to be mutually exclusive," says Damian Murray, a psychologist at UCLA.

So how might the immune system influence behaviour? In the short term, immune cells release chemicals called cytokines that seem able to cross the blood-brain barrier and interfere with brain cell activity. For example, the release of gamma interferon reduces serotonin production and makes people feel less sociable.

But some think the immune system might also affect the evolution of personality traits like conscientiousness. "In the course of evolution, humans have faced adaptive challenges caused by infectious diseases," says Valerio Napolioni at the Stanford University School of Medicine. "In addition to the immune system, human behaviour may also act as an anti-pathogen defence [by enhancing the survival of people with weaker immune systems]."

Last year, Napolioni showed that Americans who carry a variant of the *ACP1* gene, which boosts susceptibility to infections, are more introverted and less open to new experiences.

Even if conscientious and introverted people do have weaker inflammatory responses, other areas of their immune defence may be stronger, says Davies. As for extroverts, if they really are at greater risk of diseases linked to inflammation, exercise and weight loss can help.

Either way, as Cole says: "The fact that there is any relationship between your personality and what's going on in your body is helpful to know about as we think about how to lead our lives". ■

Bugs designed to only survive in a fake world

IT'S alien life, but it comes from Earth. For the first time, we've created bacteria that can survive only if they have access to substances that don't exist in nature.

Two independent groups of researchers have made *E. coli* that need artificial amino acids to function. All life on Earth uses 20 amino acids as basic building blocks, combining them to make proteins – the things that enable organisms to actually do stuff. The recipe for loading each amino acid into a protein is encoded in our DNA.

Both teams engineered bacteria to be unable to make indispensable proteins, such as those for reading DNA and interpreting its instructions, unless they had access to an artificial amino acid. To do this, they recoded the DNA language to make it load unnatural amino acids into the proteins at specific positions.

George Church of Harvard Medical School in Boston and his team used an amino acid called bipA, which is bigger than natural amino acids. Without it, the modified bacteria would make useless proteins with a large hole in their structure that no natural amino acid could fill (*Nature*, DOI: 10.1038/nature14121). The other team, led by Farren Isaacs of Yale University, did

essentially the same thing using three different artificial amino acids (*Nature*, DOI: 10.1038/nature14095).

Microbes that incorporate artificial amino acids, and which contain artificial "letters" in their genetic codes, have been made before. But these bacteria are the first to be utterly dependent on human assistance.

The main aim of the work is to make genetically modified organisms that are useful but would be unlikely to survive in the wild or swap genes

"We embedded safety features to show that these GM bacteria can't escape into the wild"

with wild relatives – the two main environmental concerns around GM organisms. "What critics of GMOs want is something where GM stays isolated," says Church. "That's why we wanted to embed these safety features, to show the bacteria can't escape."

It will be a while before GM plants could be made in this way. A more immediate application might be in upgrading the GM bacteria used for manufacturing medicines such as insulin. Andy Coghlan ■



STEVE GROSS/SCIENCE PHOTO LIBRARY

Human-made aliens

Alien world names courtesy of Japan

Jacob Aron

WHO gets to name exoplanets? As efforts to officially christen alien worlds get under way, it looks like Japanese astronomy fans will get the deciding vote.

Currently, planets outside the solar system are saddled with dull scientific designations like GJ 667 Cc or HD 40307 g. Last year the International Astronomical Union (IAU), the scientific body that oversees cosmic naming rights, announced its NameExoWorlds contest to give the public a chance to choose more evocative names for a handful of exoplanets out of more than 1800 discovered so far.

Rather than let people choose names directly, the IAU is enlisting astronomy clubs and non-profit organisations from around the world to suggest names that will then be put to a public vote. This week, the process has entered its first stage, in which the clubs will choose which 20 or so planets from a list of 305 will get names.

New Scientist's analysis of the 365 clubs currently signed up to NameExoWorlds reveals that 121 of them are based in

Japan. This far outstrips the number of groups from any other country – the second most-represented nation, the US, only has 27. This suggests that although the whole world will get to vote on exoplanet names, the list of choices may be heavily

determined by a single nation.

The IAU's general secretary Thierry Montmerle says they have extended the deadline for clubs to sign up, and hope to get wider participation.

"I agree that no country should dominate the naming," says Geoff Marcy of the University of California, Berkeley, who is part of the planet-hunting Kepler space telescope team. "I have always wanted to name each exoplanet with the word for 'peace' in different languages," he says.

You might think there are bigger things to worry about than naming alien worlds, but passions run high among space enthusiasts. In 2013, a public vote to name a newly discovered moon of Pluto after Vulcan, a planet from *Star Trek*, was overruled by the IAU for violating its naming guidelines, prompting disappointed tweets from actor William Shatner.

Meanwhile, US-based start-up Uwingu has started selling the right to propose exoplanet names, a strategy the IAU has criticised.

The issue is bound to get even more heated as our ability to detect these worlds improves.

"Planets are places," says Jason Wright, an astronomer at Pennsylvania State University in State College. "No one really cares what a too-faint-to-see star might be called by astronomers, but it's easy to be persuaded that places need names."

And if we ever manage to detect life on another planet, its name, however it is chosen, will go down in history. Of course, its inhabitants may already have picked a name for it, in which case we would have to choose whether to use ours or theirs. "If, by some cosmic coincidence, aliens have a name for their home world, in the sense that we think of names, and if humans can pronounce it, I'm sure some people will try," says Wright. ■



FRANCK ROCHON/CAMERAPRESS

I think I'll call my planet...

Fall of Soviet Union gave TB a helping hand

IT HAPPENED more than 20 years ago, but deadly consequences are being felt today. The collapse of the Soviet Union in the 1990s seems to have spurred the global spread of a killer strain of tuberculosis.

TB spreads in airborne droplets. Strains that resist standard treatments are a major health problem in countries such as Russia

and China. In Western countries, multidrug-resistant (MDR) cases are rarer, but still very contagious and hard to treat. "Patients often die from it," says Stephen Spiro of University College London Hospitals.

To uncover the source of the most common strain of MDR TB, Thierry Wirth of the Ecole Pratique des Hautes Etudes in Paris and colleagues genetically tested samples from nearly 5000 people with TB from 99 countries. They sequenced the full genome of 110 of these samples, and drew up a detailed family tree.

They found that the earlier,

non-resistant form expanded sharply during periods that coincided with the industrial revolution in the West, when large numbers of people lived together in unsanitary conditions, and also around the time of the first world war. "If people are weak or tired or lack food, this weakens the body, making them more susceptible," says Wirth.

TB began to decline in the 1960s with the introduction of antibiotics,

"If people are weak or tired or lack food, this weakens the body, making them more susceptible"

but has been on the rise again since the 1990s, which the researchers attribute in part to the collapse of the Soviet Union. This region has a known problem with MDR TB, and the social upheaval of the 1990s would have made it hard for people to access long courses of expensive drugs. Bacteria develop resistance to antibiotics when treatment is cut short.

Spiro says many of the cases he sees in London today can be traced back to Russia and Eastern Europe. "The control over treatment regimes out there is dreadful," he says. "It's chaos." Clare Wilson ■

If birds in a truck fly, does it get lighter?

IT'S a question that had US TV show *Mythbusters* filling a truck with pigeons and weighing it while getting them to fly. Now it seems there's some truth to the idea that a truck driver carrying a cargo of birds can lighten the load by making the birds fly – but it also makes it heavier.

So says David Lentink of Stanford University in California, whose team has designed a system for measuring the aerodynamic forces generated by an untethered bird in flight.

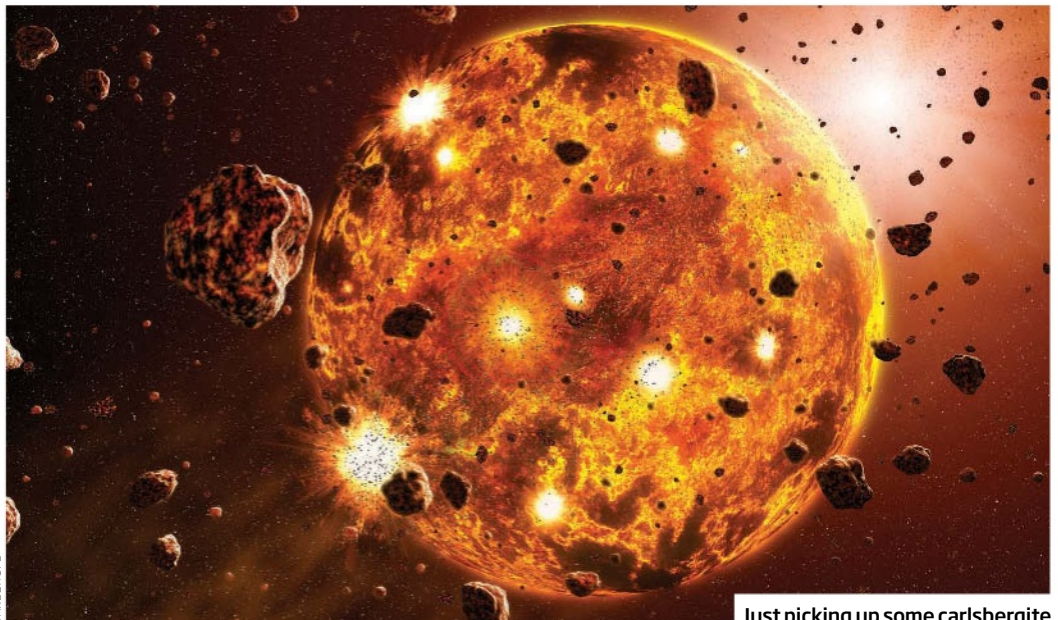
Weighing a bird on the wing isn't easy, says Lentink. As it flaps its wings, it pushes on the air both above and below, meaning its effective weight changes. To make things harder, the way it moves the air changes several times a second. "Your bathroom scales take a few seconds to determine your weight," he says. "We needed a system that was super-fast in comparison."

What they came up with is essentially a box with pressure pads on all of its interior walls that precisely measure fluctuations in air pressure 100 times each second.

By filming Pacific parrotlets (*Forpus coelestis*) taking off and landing inside the box, and measuring the forces the birds created, Lentink's team found they generate almost no vertical force on the wing's upstroke – making them effectively weightless. On the downstroke, though, they push on the air so forcefully that they generate a vertical force of up to twice their body weight (*Journal of the Royal Society Interface*, doi.org/zfm).

"So if the birds in the cargo all flap at the same time, then the lorry would have to support twice the weight of the birds during the downstroke – and none of their weight during the upstroke," says Lentink. In reality, birds tend to flap at different times, meaning the cargo will, on average, maintain a stable weight.

Their "scales" may also allow more precise measurement of aerodynamic performance of flying drones, says Lentink. Colin Barras ■



Just picking up some carlsbergite

Meteorite named after beer acts as time capsule

TAKE a deep breath. Can you taste the flavour of ancient space? Nitrogen in Earth's atmosphere has been traced back to the spinning disc of dust and gas that formed our solar system, and may even have yielded ammonia to fuel organic reactions. This all comes courtesy of a meteorite found in Antarctica named after a popular brand of beer.

"Our [meteorite] samples were collected in Antarctica in the late 1970s," says Dennis Harries of Friedrich-Schiller University in Jena, Germany. "They fell there hundreds or thousands of years ago." Known as chondritic meteorites, their history goes back some 4.6 billion years. At that time, our solar system was a vast disc of dust and gas, called the protoplanetary disc, spinning around the sun.

Harries and his colleagues were studying the make-up of the meteorites when they found a mineral called carlsbergite, named after the Carlsberg Foundation, an offshoot of the Danish brewery, which funded

previous work on it.

Carlsbergite is a rare composite of chromium and nitrogen. Looking at the ratio of stable and unstable isotopes in the nitrogen, Harries found that it was very close to the ratio in the nitrogen that makes up two-thirds of Earth's atmosphere today. That suggests they have a common

"This makes a hell of a difference, particularly if you are interested in prebiotic molecules"

origin, and the nitrogen in our atmosphere came from the protoplanetary disc.

Harries also looked at the shape of the carlsbergite crystals, and found that they must have been formed under very high temperatures, in the presence of ammonia gas (*Nature Geoscience*, DOI: 10.1038/NNGEO2339).

Knowing the molecular composition of a given element at the time Earth was formed matters, says Louis Le Sergeant d'Hendecourt of the University of

Paris-South, France. Nitrogen, for instance, can come as pure nitrogen gas or as ammonia, which also contains hydrogen. "This makes a hell of a difference, particularly if you are interested in prebiotic molecules like amino acids," he says.

Pure nitrogen is stable and unreactive, so an unlikely source for organic molecules, but ammonia can easily react to help form the organic chemistry that underpins life. So discovering that it was present even before our planet was formed may tell us something about the origins of life – although whether it helped trigger the formation of prebiotic molecules is still complete speculation.

"The presence of ammonia could have acted as an active ingredient in some of the chemistry needed to eventually get to life," says Hope Ishii of the University of Hawaii at Manoa. "But it's still a long way between having ammonia and having life."

What about nitrogen compounds elsewhere in our solar system? "It seems possible that ammonia and organic molecules were brought to other bodies like Mars and Europa," Harries says. Catherine Brahic ■

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Microelectronics : the next 20 years

This elastic market is illustrated by the ease for computers in the home. On the one hand are the disbelievers who state that there is only a small range of operations for which the householder will ever need a computer — estimating his taxes once a year, paying bills and balancing budgets once a month and very little else. On the other hand are the optimists who argue that if **microelectronics can make small computers as inexpensive as telephones then people will buy them, even though they are in use for a small fraction of the time. Once in the house, or small office, new uses will be found for them and eventually they will affect life to an even greater extent than the TV set has.** If the optimists are right then the market is huge. Other markets which are waiting to be opened up are ground and air traffic control, process control of all sorts, medical as well as industrial, and on-line reservation systems. Whether or not microelectronics has this particular future depends on improvements in what we already have today — not on new materials, new

New Scientist, 16 March 1972

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Life's a roller coaster for geese crossing the Himalayas

TALK about high flyers. Bar-headed geese migrate over the Himalayas and were once reported to fly over the summit of Mount Everest itself, almost 9 kilometres up. Now it turns out that they are a bit more level-headed when making the gruelling trip from Mongolia to overwinter in India. Instead of climbing to dizzy heights and flying horizontally over the mountains, they follow a roller-coaster route, closely tracking the contours of the terrain below.

Despite repeatedly sacrificing hard-won altitude, the geese spent less energy overall. This is paramount,

considering that the geese flap their wings for the entire journey, without taking a break to glide.

"It was 8 per cent cheaper for them energy-wise if they followed the undulating pattern of the landscape," says Charles Bishop of Bangor University, UK. His team implanted small monitoring devices into the abdomens of 29 wild geese. The information recovered from the devices in seven recaptured geese allowed the team to calculate flight paths and how much energy they burned.

The energy saving comes about because geese benefit from the higher oxygen content and air pressure at lower altitudes. Extra oxygen gives them more energy with each breath, while the greater air density allows each wingbeat to generate more forward thrust (*Science*, doi.org/zfk). "It's a double win for them," says Bishop.

Nano-vision is the stuff of diapers

WHAT'S good for babies is good for microscopes, too. A polymer used in diapers opens a new window on the fine details of cells – by making them much bigger.

Electron microscopes allow us to study cells at the nanoscale, but it's still tricky to do, especially in 3D. So Ed Boyden at the Massachusetts Institute of Technology and his colleagues turned to a polymer in babies'

diapers, which swells when wet.

They partially opened up cell membranes using a detergent, allowing the polymer's building blocks to seep inside. Then they triggered a reaction that causes the building blocks to polymerise.

Finally they added water, making the polymer, and the cells, swell up to around four and a half times their original size – a 100-fold increase in volume. That

brings fine details – including 3D structures – into view using standard optical microscopes (*Science*, doi.org/zh6).

Boyden's team hope to use the technique to help spot where tiny proteins are located on brain cells, which are difficult to image using standard microscopy. These proteins play a vital role in the way neurons connect to each other. "It could reveal which proteins are there and what they are doing," says Boyden.

Cosmic radio burst finally glimpsed

IT WAS over in a flash – but a giant, fleeting burst of radio waves has been spotted as it happened for the first time.

These fast radio bursts last about a millisecond but give off as much energy as the sun does in a day, all seemingly in a tight band of radio-frequency waves. Nine have been reported since 2007, but all emerged from old data weeks or years after the actual event.

Now, Emily Petroff of Swinburne University, Melbourne, and her colleagues have caught a blast in the act with the Parkes Telescope in New South Wales, Australia (arxiv.org/abs/1412.0342).

Their origin is still a mystery, but whatever it is must be huge and cataclysmic, Petroff says. A top contender is the collapse of an oversized neutron star, or a flare from a magnetar, a type of neutron star with an extremely strong magnetic field.

Cunning snails drug fish then eat them

IT'S the first known case in the natural world of murder by insulin. Some cone snails eat live fish whole. So why don't the fish fight back and escape? Because they have hypoglycaemic shock.

The snails spray a cocktail of chemicals, including a type of insulin, at the fish. Animals make insulin to remove glucose from their blood. But if the blood sugar level drops too low, it can make them disoriented and weak.

Helena Safavi-Hemami at the University of Utah in Salt Lake City and her team, who are studying the snails, say it is the shortest insulin molecule ever seen. It quickly makes the fish sluggish and its secrets could lead to better drugs for diabetes (*PNAS*, DOI: 10.1073/pnas.1423857112).

Why the temper tantrum, Uranus?

STORMS have clouded Uranus's normally placid face. In the past year, the gas planet has played host to huge cloud systems so bright that even amateur astronomers can see them from Earth – and their cause is a mystery.

"We have no idea. It's very unexpected," says Imke de Pater at the University of California, Berkeley.

De Pater observed Uranus on 5 and 6 August, 2014, and was surprised to spot unusually bright features, the hallmark of clouds condensing in the planet's upper atmosphere. "It was brighter than anything we had ever seen in Uranus's atmosphere before," she says. The planet's weather generally picks up at its spring and autumn equinoxes every 42 years, when the sun shines on the equator. But the last equinox was 7 years ago, so the recent spike in activity is difficult to explain.

De Pater's group spread the word, and amateurs around the globe trained their telescopes on Uranus. Coincidentally, the amateurs spotted a storm that de Pater had imaged at a different wavelength on 5 August. Using the Hubble Space Telescope, de Pater and her colleagues saw storms spanning a variety of altitudes (arxiv.org/abs/1501.01309), which could be linked to a vortex deep in Uranus's atmosphere.

Micro-missiles hit home in live mice

TINY torpedoes are go! Micromachines have journeyed through a living animal for the first time, delivering a test cargo of gold nanoparticles into the lining of a mouse's stomach. The breakthrough could lead to a better way to deliver drugs to their target.

Micromachines promise to revolutionise the diagnosis and treatment of a wide array of illnesses. But these devices had only been tested in the lab using cell samples – until now.

Wei Gao at the University of

California, Berkeley, and his team fed mice 20-micrometre-long conical polymer tubes coated in zinc. When the machines reach the stomach, the zinc reacts with stomach acid to generate hydrogen bubbles.

These bubbles propel the tube forwards, turning it into a mini torpedo that travels at 60 micrometres per second. This is fast enough for the tubes to lodge themselves in the mucus lining of the stomach wall, say the team, where they could deliver a payload of drugs to treat peptic

ulcers, gastritis or gastric cancer.

In tests, the team loaded the micromachines with gold nanoparticles in place of a drug, as these show up better in microscope analysis.

A control group of mice were fed gold nanoparticles that hadn't been loaded into the micromachines. The team found that the micromachine-fed mice retained three times as many gold nanoparticles in their stomach lining, showing that the mini-torpedoes are more effective (*ACS Nano*, doi.org/zcz).

Why antibiotics and malaria are bad mix

HEALTH advocates stress the merits of antibiotic-free food – but we are not the only beneficiaries. Mosquitoes that suck the blood of people with malaria are more likely to pick up the infection if the person is taking antibiotics.

The malaria parasite, *Plasmodium falciparum*, reproduces sexually in the mosquito gut. But its ability to do so is compromised by the gut bacteria – perhaps because the gut microbes and *Plasmodium* compete for the same nutrients.

Mathilde Gendrin at Imperial College London and her colleagues found that allowing mosquitoes to feed on blood carrying penicillin and streptomycin cut the number of bacteria in the insects' gut by 70 per cent – and left the mosquitoes 21 per cent more likely to develop a malaria infection (*Nature Communications*, doi.org/zfn).

Gendrin says the findings reinforce the view that people taking antibiotics – particularly if they carry malaria – should take steps to break the malaria cycle. For instance, they should sleep under netting to lower their risk of being bitten by mosquitoes.



MATJAZ KUNTNER

Coin spiders chew off their genitals

WHY carry the extra baggage when castration can make you more agile? For male coin spiders that mate once in a lifetime, chewing off their heavy genitals after sex makes sense. It makes them more agile and better at fighting off rivals that could fertilise the same batch of a female's eggs.

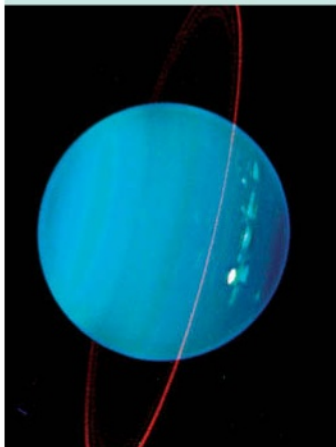
It is extreme monogamy. "Males put all their eggs in one basket and focus on a single female," says Matjaž Kuntner from the Slovenian Academy of Sciences and Arts in Ljubljana.

His team found that eunuchs stayed closer to females and attacked rivals more aggressively

than their virgin competitors.

They also stayed active for around 40 per cent longer than non-maters when harassed by a researcher's paintbrush, presumably because they did not have the heavy sperm-transferring "palps" weighing them down (*Behavioral Ecology and Sociobiology*, doi.org/zfv).

Kuntner could not rule out the act of copulation itself giving the spiders a boost, but he thinks self-castration almost certainly increases the spider's motivation and aggression. With only one shot at mating, they will do whatever it takes to stay ahead.



Doctors will soon be able to read all our genes for less than the price of a holiday in the sun, while smartphones already have the capacity to keep an eye on our day-to-day health.

What are the implications for science and society?



Find out by joining:

Jonathan Dimbleby

George Freeman MP, Minister for Life Sciences

Dr Leroy Hood, whose leadership led to automated DNA sequencing

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With the price of DNA sequencing plummeting, and the increasing smartness of handheld electronics and point-of-care diagnostics, the prospect of personalised medicine fine-tuned to a patient's genetic make-up no longer seems a far-off dream. Health apps are already giving the public unprecedented opportunities to monitor and manage their own fitness; in the future, we're promised, technology and genomics will combine to utterly change the patient's experience.

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Want a piece of me?

Shared housing

Crowdsourced loans and peer-to-peer lending are cutting banks out of the mortgage market – and this is just the start, finds **Chris Baraniuk**

NEED a mortgage? In the near future you may find yourself canvassing strangers online for a loan instead of your bank. The rise of a new kind of crowdfunding website is opening up the potential for everyone to take part in – and profit from – financial services, without a bank in sight.

Peer-to-peer (P2P) lending, which connects those who need money with those looking to grow their own, has enjoyed a dramatic rise in popularity in recent years, fuelled by a shortage of credit at one end and lacklustre interest rates at the other.

The trend began in earnest when sites like Zopa began helping people secure personal loans through crowdsourced funding. But now an increasing number of peer-to-peer investors are looking to get a slice of the property market.

The system works by allowing people from all walks of life to pool their money and act as a lender to a home buyer. Investors

sign up through a website where loan requests are published alongside details about the applicant. Once you have decided who to lend money to, you can invest as little as £100 in the mortgage. In the UK, there are rarely limits on the maximum investment you can make, and interest is typically paid back to you monthly. Regulatory oversight for the area is growing too, with bodies such as the P2P Finance Association now enforcing rules on its members.

Growing enthusiasm for the model is giving the companies who manage peer-to-peer lending arrangements big ideas. “P2P is a large part of the current strategy, but it’s really about opening up the mortgage market to be accessible purely online for people,” says Ian Thomas, co-founder of LendInvest.com, which offers P2P mortgages. “That’s the real power of what we’ve created.”

LendInvest users can choose from a range of high interest, short-term loans requested

BUYING HOUSES BY THE BRICK

Retiree Roger Hockin discovered crowdsourced property investment site The House Crowd while casually browsing the web. The company owns almost 100 properties and has raised over £7 million to date.

Hockin says that after two years, he’s very happy with the investment he made on a single property, especially when compared to the

rates attached to traditional retail savings accounts.

“Overall, providing you’re prepared to invest pretty long-term, the return you’re getting in comparison to the banks is very good,” he says. “I’m getting 6 per cent. If you go to the bank you’ll end up with 0.5 per cent or something silly.”

by residential and commercial mortgage seekers. Loan repayments net those investors a monthly fee, which the company says sits at an average of around 6.5 per cent.

Danny Cox, a spokesman for financial services company

“I’m getting a 6 per cent return. If you go to the bank you’ll end up with 0.5 per cent”

Hargreaves and Lansdown, says that the UK’s rock-bottom interest rates since 2009 have encouraged the rise of such “alternative finance”. This is now leading some to question the need for banks for certain financial transactions. “The amount of money spent on P2P is still small, a little over a billion pounds in the UK, though the market is growing very rapidly,” Cox says.

There are risks, however. Cox points out that commercial properties generally carry a higher risk of buyers defaulting on their payments. “The key to the continued success of P2P is the correct assessment of risk,” he says.

If P2P firms aren’t transparent about the risks facing investors, that could create a situation in which expected returns fail to materialise. Some also worry that the credit score demands on P2P borrowers might be relaxed to encourage market growth.

Crowdfunding is also making it easier for investors to enter the buy-to-let market (BTL) without needing to buy a property outright (see “Buying houses by the brick”, left).

Last year, the Royal Institution of Chartered Surveyors (RICS) expressed concern about the “liquidity shock” that BTL crowdfunding posed to the housing market by making the purchase of a share in a house “as easy as ordering a book on Amazon”.

An internal paper shared with *New Scientist* estimates that if 5 per cent of household savings



◀ in the UK were invested in these schemes, it would add an extra £50 billion to the country's housing market over three years, probably exacerbating house price volatility. As well as the danger that greater access to property investment collectives will drive houses prices even higher, the RICS report notes that the schemes will require policymakers to rethink how they manage the property market.

But buying property through crowdfunding could also limit the dominance of big-time investors. Aifuwa Ehigiator is the founder of a start-up called Our Street, which hopes to allow the people of Brooklyn in New York a chance to invest in local properties. They will jointly provide the money to buy the houses, which will then be refurbished and made more eco-friendly before being rented out for profit.

Ehigiator says he has nearly 200 locals who are interested in investing and, provided additional commitments can be secured, he hopes to launch the venture in the coming months.

Thomas believes crowdfunding initiatives could change the face of the housing market. LendInvest looks set to focus on financing mortgages, but with over £200 million invested through loans listed on the site so far, the race to upset the banks has only just begun.

"Everyone is picking a different segment of the market, whether it's business loans or mortgages," he says. "Banks will eventually become more like transactional providers, and specific products will be done more and more by P2P."

However, traditional banks aren't on the ropes yet. It's possible that as confidence in the economy grows, they will begin retaking their lost share of the market. This would leave P2P lenders with the less desirable assets, and their risk spread thinly across a pool of borrowers with an uncomfortably high default rate. ■

A city of numbers

The more data cities have, the better they can operate

Hal Hodson

IN EUROPEAN terms, it's barely a toddler – but Boston is one of the oldest cities in the US. It has gnarled streets, a slow, rumbly subway and red-brick buildings that date back to the revolution. But behind the history is a modern approach to city management that's making life easier for its citizens – and it's all thanks to data.

Earlier this week, Uber, the meteorically successful car-bookings platform, announced that it would share its ride data with Boston, making it the first city in the US to receive data from the firm. Starting in two weeks, then updated every quarter, Boston will get zip codes in which Uber rides begin and end, the timing of rides and the distance travelled.

Jascha Franklin-Hodge, the city's chief information officer, says Uber's data will help his team assess the impact of city development on residential mobility, measuring commute and travel times between different neighbourhoods.

The Uber data set will join a wide range of others in Boston's store. Like cities around the world, it has collected data from its public

transport system, cellphones and taxi records to quietly transform and improve itself. For example, it is already using data from the public transit system to understand the impact an overpass demolition in south Boston is having on local residents.

"Cities have used data forever really," says Alan Wiig of Temple University in Philadelphia.

"What's new now, what this announcement signifies, is the speeding up of how quickly cities can use data."

Other cities are also seeing the advantage in pooling data to make life smoother for residents, says John Polak of Imperial College London. For example, data from London's transport system helped the city prepare for an influx of



Smart clothes track health in pregnancy

WIRE up your baby bump in style.

The latest in smart maternity clothes can track the vital signs of pregnant women via conductive silver fibres woven discreetly into the fabric.

The clothing line, designed by Blake Uretsky, a fashion student at Cornell University in Ithaca, New York, aims

to help pregnant women keep tabs on their changing bodies.

"Maternity wear is a market that needs to be revamped aesthetically," says Uretsky, who thinks wearable tech often struggles to be both attractive and useful.

To learn more about pregnancy fashions, Uretsky donned a fake bump and visited several stores to try on their clothing. She also interviewed 30 local mothers about their experiences with maternity wear.

The result was "B" Maternity

Wearables, a line of 10 pieces including blouses, trousers, skirts and even an evening gown. The clothing comes in neutral colours and adjusts to a growing bump.

Silver wires made by Pennsylvania firm Notable Biomaterials are threaded through the empire waistline and register the wearer's temperature, heart rate, blood pressure and respiration. A small device on the belt relays this data back to a smartphone app. With the help of doctors, users can set the app

visitors during the 2012 Olympics.

One of the diverse data sets that Boston already uses is of the sudden traffic jams that occur, perhaps because of a double-parked lorry. Boston's Traffic Management Center sees the jam as soon as it starts. The centre receives anonymised cellphone location data from a company called Inrix and crowdsourced traffic alerts from the Waze navigation app. "We'll use the camera infrastructure to try and understand what's happening," Franklin-Hodge says. The fix for a double-parked truck is to extend the length of the green light at the

junction ahead of it, allowing more time for slow-moving cars to get out of the jam.

Technological solutions can make residents' lives easier, but they can also give managers new insights into their cities. Chris Osgood of the Mayor's Office of New Urban Mechanics in Boston says wiring 320 downtown parking spots with occupancy sensors paid off not just by letting drivers find open spots through an app called Parking, but by helping the city managers see where they needed to change their policies.

Osgood and his team identified a number of spaces that were constantly occupied, and reduced their maximum occupancy time from 4 hours to 2 hours. Other spots were underused, and had their maximum times bumped up accordingly.

"We have trash and recycling barrels throughout the city that are equipped with sensors," Franklin-Hodge says. "They can inform us in real time when they are getting full. As we analyse that data over time, it lets us plan where to put resources to collect trash."

Franklin-Hodge says he expects the Uber data set to be just one in an increasing portfolio derived from private companies. "The city can't just look inwards at its own databases," he says. "It has to recognise that consumer services are generating a trove of data that's valuable to us. The Uber agreement is the tip of the iceberg." ■



HUNTSTOCK/INCALARY

Watch and learn

to ping them if their vital signs veer out of whack - perhaps because of stress or inactivity. Earlier this month, the clothing line won an award from the YMA Fashion Scholarship Fund, a non-profit in New York City.

Most pregnant women don't need to constantly monitor their vital signs, says Julia Walsh, a maternal health

expert at the University of California at Berkeley. But women with high-risk pregnancies or who enjoy tracking devices like the Fitbit, for example, could get a lot out of it.

Owen Montgomery, an obstetrician at Drexel University in Philadelphia, working on a wearable fetal monitor, can see doctors getting behind the concept too: "If you could put on your maternity garment, and then have your blood pressure sent electronically to your doctor's office every morning, that's really sweet." Aviva Rutkin ■

"Silver wires in the empire waistline can monitor temperature, heart rate and blood pressure"

ONE PER CENT



Google Glass: dead or quietly evolving?

Glass shut up shop last week. Google said its high-profile wearable computing project was "graduating" from its original home in the company's secretive X lab, and that it is still working on new versions of the device. The firm also said it was closing its Explorer scheme for developers to get their hands on Glass. Many interpreted this as Glass being discreetly eased out of the limelight.

It wouldn't be a huge surprise. The device was unwieldy and had bad battery life, a terrible display and limited input options. Its unappealing aesthetic, combined with the potential for surreptitious video recording, earned its wearers the nickname Glassholes.

But it's unlikely that Glass is indeed dead. Consumers may have rejected its high price tag, but business and industry were kinder. Surgeons, who value hands-free access to patient data, were particularly keen.

And although Google's initial foray into spicing up our field of view may be over, a future in which computers augment our senses is still very much on the cards.

"Our focus is on creating a global communications system that would be larger than anything that has been talked about to date"

Elon Musk tells Bloomberg about his latest grand venture: hundreds of satellites providing global high-speed internet access

A picture can be a vital sign of one's love

Every breath you take, I'll be watching you. A high-tech photo frame billows its surface in time with the breaths of the person pictured, picking up their breathing pattern from a sensor-studded belt they wear. The gadget - developed by Jina Kim and colleagues at the Korea Advanced Institute of Science and Technology in Daejeon, South Korea - aims to help couples feel closer when they're apart. It was presented last week at a conference at Stanford University in California, along with positive feedback from eight couples who tried it.





School's out on the reef

A SMALL school of grunts is unfazed by the photographer as they swim over this tiny coral oasis off Florida's coast. But this is no ordinary reef: it has been made by biologists trying to farm corals to transplant onto damaged reefs. Many species are in need - staghorn coral (*Acropora cervicornis*), the kind pictured, has experienced a 98 per cent decline over the past 30 years, leaving it scattered and facing local extinction.

"The images show two approaches to the same problem: getting coral fragments to grow into healthy coral pieces," says Tim Calver, the wildlife photographer who shot these images off the coast of Key Largo, at the very top of the Florida Keys. The coral is clipped from healthy stock then glued to cement blocks or tied to vertical strings, where it is elevated into the current, its nutrient source. It is left to grow for a few months until it's big enough to be transplanted.

This nursery is run by the Coral Restoration Foundation, whose president, Ken Nedimyer, can be seen below inspecting the growth of baby corals. The organisation has replanted thousands of colonies - most of which have survived. "To be in the water and to know it's a success story is just fantastic," says Calver. Mico Tatalovic



Photographer

Tim Calver

timcalver.com

Health of nations

If you want to know what makes a whole society sick and how to make it well again, look no further than Scotland, says **Harry Burns**

LAST year, just before the Commonwealth Games, figures came out showing that the host city, Glasgow, has the lowest average life expectancy of any UK city. A boy born there between 2010 and 2012 can expect to live just 72.6 years, against a national average of nearly 79.

This was hardly news. For many years, parts of Glasgow have had the UK's highest premature mortality rate. The popular belief is that this is because of diet, smoking and drinking. Only one of these factors is genuine: Glaswegians drink too much.

In fact, most preconceived notions about the bad health of Scots are wrong. Research into its real causes has implications for health policy internationally.

There is nothing inherently unhealthy about the Scots. The Glasgow Centre for Population Health has charted life expectancy in several Western European countries for the past 160 years. For most of that time, Scotland's was about average. Only in recent decades have other countries overtaken it. This slowing of the rise in Scotland's life expectancy has been most marked in the poorest 20 per cent of the population, mainly because of increases in deaths due to drugs, violence, alcohol and suicide. From 1950 to 1970, Scotland had one of the lowest rates of death from alcoholic liver disease, for example. By 2005, it had the highest.

Put simply, widening health inequality in Glasgow is due to the recent emergence of socially determined causes of early death.



What happened to cause this?

During most of the 20th century traditional industries, such as shipbuilding and steel, provided secure, meaningful employment for Glasgow. These industries declined in the 1970s as companies shifted production abroad. Skilled people left and those who remained struggled to find jobs. At the same time, communities changed as inner-city tenements were replaced by peripheral housing estates which lacked the same social cohesion. From this emerged a society with a deep sense of alienation.

However, research tells us that this is not something we have to accept. It is clear societies have the

capacity to create well-being. We have become used to relying on healthcare to prevent and treat illness. Perhaps it's time we asked: how do we create wellness?

There are many theories of well-being, but they share common features. Healthy, successful lives tend to be lived by people with a sense of purpose and meaning. They feel that they are masters of their own fate rather than being at the mercy of events, have a positive outlook and see problems

"Healthy, successful lives tend to be lived by people with a sense of purpose and meaning"

as challenges to be overcome. It turns out that individuals who lack these attributes experience significant consequences.

People who don't feel in control of their life are stressed by it. Many studies have shown that the lower down a social hierarchy an individual is, the higher the levels of stress hormones in their blood.

It appears that early childhood experiences can also produce lifelong abnormalities in the stress response. Young animals exposed to chaotic, inconsistent parenting have high levels of stress hormones.

Stress is also associated with abnormal patterns of brain development in key areas, including the prefrontal cortex, hippocampus and amygdala. These are important for learning, decision-making, memory, stress regulation and emotional arousal.

These developmental patterns are also seen in humans. So young animals – and young humans – who grow up in dangerous, chaotic environments are likely to be less able to suppress inappropriate behaviour, less able to learn and more likely to be anxious and aggressive.

These observations are not specific to Scotland. Studies elsewhere find the same relationship between turbulent early years and adult outcomes. The California Adverse Childhood Event study, for example, looked at nine types of childhood event and how they related to problems in adulthood such as alcoholism, drug abuse and domestic violence. None of these events were particularly damaging on

their own, but the more of them an individual experienced, the more damaged their adult life was likely to be and the more likely they were to experience addiction, violence and mental health problems.

It may be that what we are seeing in Scotland is the consequence of austerity in the 1970s and 80s, when social change and joblessness led to a breakdown in family life and a cycle of alienation. Young people with no meaning and purpose tend to sit at home, watch TV, drink and have a couple of kids – and the cycle continues.

Plenty of other societies are experiencing the same kind of problems. What we have seen in Glasgow may become evident in southern Europe over the next two decades.

Can we fix it? Yes, but it will take time. The importance of investment in early childhood cannot be overstated. Breaking the cycle of alienation in young families is a first step. But it won't happen overnight.

We are fortunate in Scotland in having politicians who are guided by science. They back a radical approach and novel methods to make Scotland the best place in the world to grow up.

I'm not advocating a revolution in the normal sense of that word. However, we need a revolution of a sort. A more consistent application of science to policy can radically improve quality of life and the opportunities for young people to realise their potential for health, happiness and attainment in life. We are fortunate in Scotland to have such political support. There is no reason why, in a few decades, life expectancy in Glasgow should not match the best in the UK. ■

Harry Burns is professor of global public health at the University of Strathclyde in Glasgow, UK, and a former chief medical officer for Scotland. This article is based on a lecture he gave at a New Scientist Live event in Glasgow

ONE MINUTE INTERVIEW

Goal: 100,000 genetic clues

The 100,000 Genomes Project is a bold bid to understand the causes of cancer and rare diseases, says **Maria Bitner-Glindzicz**



PROFILE

Maria Bitner-Glindzicz is a clinical geneticist at the Institute of Child Health, University College London. She is also a clinician at Great Ormond Street Hospital, where she recruits people with rare diseases for the 100,000 Genomes Project

What is the 100,000 Genomes Project?

It's an England-wide initiative to gather and analyse 100,000 entire human genomes. We will examine two major groups – patients with rare diseases, which is my remit, and patients with cancer. Recruitment starts next month.

Will it actually involve 100,000 people?

Not quite, because each volunteer with cancer will provide two genomes, via blood and tissue samples. We need to record the genetic make-up of their healthy cells and that of their tumour. For rare diseases, we will aim to get the genomes of the affected person and their parents, ideally.

How will this help us deal with rare genetic conditions?

For a person with a rare disease, even getting a diagnosis can be a very long process. Parents may know their child has many medical problems, which often begin at birth or shortly after, but no one can tell them what their child has, if they will be intellectually normal, disabled, what the child's

lifespan will be... It's scary, and it's no good all your doctors saying, "Oh, how interesting, your child has this sort of condition. Gosh, I've never met anyone with that." The project will increase our knowledge of a lot of rare disorders.

Once the genomes are logged, how easy will it be to pin down the causes of rare diseases?

That's the million-dollar question. For some, a genetic change will be obvious, in a gene that perhaps we've known about for some time. For others it may be less obvious. But comparisons across the huge data set will be really powerful. Even if someone has a very rare condition – one that perhaps only four or five other people in the entire project have – at least we'll be able to compare them and ask what they have in common.

Are people keen to volunteer?

I think the more severe a rare disease is, the more likely people are to participate. I've been sought out by a number of parents who have children with severe medical problems.

Will you help participants make sense of their own genomes?

Yes, that's important. Many people with rare diseases see a geneticist for counselling or are seen often by a clinician, who will help explain the results.

A parent who gives their genome because their child has a genetic disorder will also be offered personal feedback about important findings – if, say, we find they have a genetic change that gives a high predisposition towards certain cancers.

How soon could the work lead to treatments?

Once genetic disorders are teased apart, there may be relatively quick treatments for some, where there is already an approved drug that can influence the metabolic pathway involved. For others it's going to be a much longer journey. A number of treatments for genetic diseases are already being designed and trialled, and in the next five to 10 years that's going to accelerate.

Interview by Penny Sarchet



Don't let Earth's tapestry unravel

Rampant tribalism is carrying us into a bleak future.
We must face reality, and soon, says **E.O. Wilson**

Fascinated by some of
the littlest creatures
and tackling some of
the biggest questions

JASON GROW

Your new book, *The Meaning of Human Existence*, addresses a huge question.

What inspired you to tackle it?

I think it's time to be audacious. The central questions of religion and philosophy are three in number: where do we come from, what are we and where are we going? Usually these are just the beginnings of long discussions, but that's no longer the case. We now have a pretty good picture of how humanity arose in Africa, what intermediate forms existed, the rate at which these forms evolved and the circumstances in which they evolved.

So I can say, right now, that of those three great questions, we have most of the answer for where we come from. And in this book I take up the question: what are we? We're starting to close in on that one. We need to know where we came from and what we are to have the self-understanding to sensibly plan where we're going. Right now, we don't have any idea where we're going.

Would you say there is a lot of denial about where humanity is heading?

Well, there's immense disagreement. One of my favourite quotations is from the late French author Jean Bruller, who wrote under the pseudonym Vercors. He said that all of man's problems derive from the fact that we do not know what we are, and cannot agree on what to become.

So will you examine humanity's future next?

I'm writing a trilogy. The first was *The Social Conquest of Earth*, which dealt with where we come from. *The Meaning of Human Existence* deals with what we are. And the final part, *The End of the Anthropocene*, will look at where we are going.

The major theme of that upcoming book will be that we are destroying Earth in a way that people haven't appreciated enough, and that we are eroding away the biosphere through species extinction, like the death of a thousand cuts. I want to examine the new ideology of the anthropocene – namely those who believe that the fight for biodiversity is pretty much lost and we should just go on humanising Earth until it is peopled from pole to pole; a planet by, of and for humanity. It sounds good, but it's suicidal.

PROFILE

Entomologist E. O. Wilson is a professor emeritus at Harvard University. He is the founder of the E. O. Wilson Biodiversity Foundation, based in Durham, North Carolina. His latest book is *The Meaning of Human Existence* (Liveright, 2014)

Why is biodiversity loss suicidal for humans?

The biosphere is an extremely complex system, and razor thin: if you look at it from the side, from orbit, you can't even see it with unaided vision. That's where we live, and that's what produced us, plastered on the surface of our planet. We were not just created separately in some manner and then lowered into the biosphere. Everything about us – our minds, our bodies – is conditioned to exist in those exact conditions created by our biosphere.

The beautiful equilibrium of the living world is a result of all the species, plants, animals and microorganisms around us. As it is eroded away, the living world is almost certainly going to reach a tipping point where its equilibrium is going to decay and unravel. And when that happens, the whole thing collapses – and we collapse with it.

Why does our species seem to ignore scientific warnings about Earth's future?

I think primarily it's our tribal structure. All the ideologies and religions have their own answers for the big questions, but these

"Eroding the biosphere with species extinction is like the death of a thousand cuts"

are usually bound as a dogma to some kind of tribe. Religions in particular feature supernatural elements that other tribes – other faiths – cannot accept. In the US, for example, if you're going to succeed in politics, it's a prerequisite to declare you have a faith, even if some of these faiths are rather bizarre. And what they're saying is "I have a tribe". And every tribe, no matter how generous, benign, loving and charitable, nonetheless looks down on all other tribes. What's dragging us down is religious faith.

Is atheism the answer?

In fact, I'm not an atheist – I'm a scientist. Atheism is the belief that there is no god, and you declare there is no god: "Come, my fellow atheists, let us march together and conquer those idiots who think there is a god – all these other tribes. We're going to prevail."

I would even say I'm agnostic because I'm a scientist. Being an agnostic means saying, dogmatically, that we will never be able to know, so give it up. The important thing is that it appears that humans, as a species, share a religious impulse. You can

call it theological, you can call it spiritual, but humans everywhere have a strong tendency to wonder about whether they're being looked over by a god or not. Practically every person ponders whether they're going to have another life. These are the things that unite humanity.

If humans have a built-in spiritual yearning, can we do anything about it?

This transcendent searching has been hijacked by the tribal religions. So I would say that for the sake of human progress, the best thing we could possibly do would be to diminish, to the point of eliminating, religious faiths. But certainly not eliminating the natural yearnings of our species or the asking of these great questions.

You pioneered sociobiology and discovered pheromone-based communication. But is there a scientific conundrum that you wish you had been the one to crack?

I would like to have discovered the structure of DNA, but a couple of Brits and an American beat me to it. Everybody would like to make a discovery like that. But the question I most want answered now is whether or not there's life on other planets. I've just got to know!

From all these big questions to the smallest creatures... I cannot interview the world's best known ant expert without asking: do you have a favourite?

I do. It's an ant called *Thaumatomyrmex*. In all my travels, I've only seen three. They're very rare. It has teeth on jaws that look like a pitchfork. The teeth are extremely long, and when it closes the jaws, they overlap. In at least one species, the teeth actually meet behind the head. So what does this monster eat? What does it use those teeth for? I just had to know, so I sent an appeal out to younger experts in the field, particularly in South America, where these ants are found.

Eventually they discovered the answer: it feeds on polyxenid millipedes. These millipedes have soft bodies, but they're bristling all over like a porcupine. So the ant drives a spike right through the bristles and nails it. And what we hadn't noticed is that the ant also has thick little brushes [on some of its limbs], and members of the colony use these to scrub the bristles off – like cleaning a chicken – before dividing it up. That's my favourite. ■

Interview by Penny Sarchet

What's the beef?

It's linked to cancer, heart disease and obesity. So will quitting meat save our bacon? Linda Geddes reports



BACON causes breast cancer; chops clog your arteries. The headlines are clear – if you care about your health, you shouldn't be eating meat. Once considered the star attraction of a balanced, healthy plate of food, meat is now linked to obesity, heart disease and cancer. Add the environmental concerns over a growing global appetite for meat, and it seems meat should now be an occasional guilty pleasure rather than a daily staple, or so we are told.

Yet the evidence isn't quite as clear-cut as the headlines suggest, and not everyone is convinced of the perils of tucking into a juicy steak. A growing body of research – which is, perhaps unsurprisingly, being championed by the meat industry – suggests that recommendations to cut down on or give up meat altogether are too restrictive and could even be doing us more harm than good. Who should we believe, and are the dire warnings about the health risks of eating meat justified?

BRAVE NEW MEAT

It's probably time to cut down on preservative-laden processed meats like cured sausages (see main story). But you could soon be tucking in to a safer hot dog, one in which cancer-causing preservatives are replaced by new, plant-derived antioxidants. They have already been shown to prevent microbes from growing in meat. What's more, the produce had a shelf life acceptable to meat producers, with the right colour and texture. It will be a while before these phytochemical sausages hit the shops, though, as they need to be safety-tested.

In the meantime, how about heading out for a cricket burger? The first edible insect farm opened in the US last year and the critters are protein-rich and easy on the environment. They can be reared in a fraction of the space needed for farmyard animals, their waste contains

less polluting ammonia, and they emit fewer greenhouse gases.

There is still the yuck factor to overcome, of course, and for now, buying insects that taste nice costs far more than buying the equivalent amount of steak.

Others would rather do away with whole animals, pinning their hopes instead on lab-grown cuts, which would require less than 1 per cent of the land, consume about 4 per cent of the water and about half the energy as the same amount of farmed beef. But many doubt whether lab-grown meat will ever be cheap enough to produce commercially. Plus, unlike meat from an animal, the lab-grown stuff has no in-built immune system, so contamination is a potential issue. Lab-produced meat also requires a product of cattle slaughter – fetal calf serum – to grow.

The first hints that meat isn't all it's cut out to be came in the 1970s, says Denis Corpet, who studies the role of diet in cancer at the University of Toulouse in France. "Surveys started to show that countries that eat a lot of meat see more colorectal cancer than countries where people eat very little."

That link to cancer was more firmly established in 2007, with a World Cancer Research Fund (WCRF) report which pulled together the results of 14 studies, concluding that red and processed meats were "convincing causes of colorectal cancer". It suggested cutting out processed meat altogether and eating no more than 500 grams of red meat per week, prompting newspaper headlines such as "a sausage a day can increase bowel cancer risk". For most other cancers, the evidence is less convincing, says epidemiologist Teresa Norat at Imperial College London. "The evidence is really for colorectal, and probably stomach cancer."

Of course, meat has gained its unhealthy reputation for other reasons as well. Two large studies published in 2012 found that the risk of dying from all causes – including bowel cancer and heart disease – during the study follow-up period was 13 per cent higher for people eating 85 grams of red meat per day, and 20 per cent for those eating 85 grams of processed meat. That would translate to roughly a year off life expectancy for a 40-year-old man who eats a burger a day.

If these studies are to be believed, that's a lot of lives potentially being shortened by meat-eating. UK dietary surveys show that 4 in 10 men and 1 in 10 women eat more than 90 grams of red and processed meat a day on average.

But matters are complicated by the fact that studying exactly what people put in their mouths is notoriously tricky. For the most part researchers have had to go on what people say they eat, which can be unreliable. And diet is intricately linked to other lifestyle factors that affect health, not to mention the fact that studies vary in the way they are carried out: many don't make a distinction between ►

SIMON DAVAHER

THE RAW FACTS

Daily staple or public enemy?

Meat is a one-stop-shop for essential amino acids – the ones the body needs to build proteins but can't make on its own. It is also a rich source of vitamin B12, iron and protein, all of which are often lacking in plant-based foods.

But the types of meat we eat, and how much, matter. We are now eating meat in unprecedented quantities, and demand is growing, especially in developing nations.

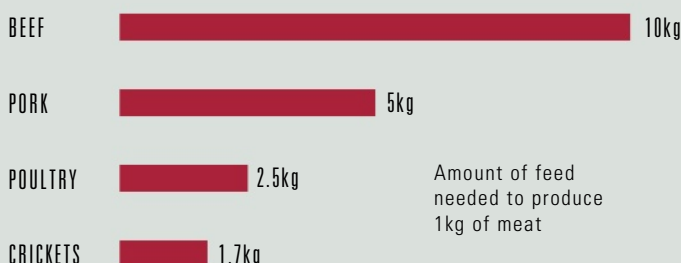
The kinds of meat we consume are also changing. In the UK, we are buying less fresh meat and more meat in the form of pre-prepared meals, which might contain added sugar, fat, salt and preservatives (see graph, page 35). While there's little indication that white meats like poultry, or fish, are a health concern, the evidence for red processed meats like bacon, salami and ham is not encouraging (see chart, right).

All this raises concerns for our health and the environment. However, eating the right kinds of meat can be beneficial for both (see "Red meat can be green", page 34).

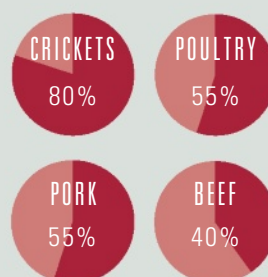
As well as vitamins and the like, meat contains a lot of protein for its calorie content (facing page), so although other foods give us protein too, meat is the most efficient source. Avoiding it could make it harder to get a healthy, balanced diet.

COSTLY CUTS

The greediest animals to farm are also the poorest meat yielders



Percentage of animal that is edible



An individual's annual meat consumption varies widely by country

122kg

US

84kg

UK

58kg

CHINA

Processed versus fresh

The evidence is conflicting, but it seems that preservatives in processed meat could lead to carcinogenic compounds being formed in the gut

CANCER RISK

Even fresh, lean red meat is rich in haem, which creates cancer-causing compounds when it reacts with fats and oils

A study of almost 40,000 men found that for every 50g of meat consumed daily, the incidence of heart failure rose by 8 per cent and the risk of death from heart failure by 38 per cent

HEART HEALTH

The study (left) found no effect for unprocessed red meat. But other studies show gut bacteria can convert L-carnitine in red meat into a compound which inhibits cholesterol removal from arteries

Processed meat often contains high levels of salt, sugar and fat

NUTRITIONAL VALUE

Fresh meat is a good source of essential amino acids, iron and vitamins, especially B6 and B12

Adults need around 50 grams of protein per day. Steak could give you this plus other nutrients. Other sources may not be so practical

200g

Steak serving
Cals - 407
Vit B12 - 3.32µg
Vit B6 - 1.2mg
Iron - 3.6mg
Sat fat - 7g



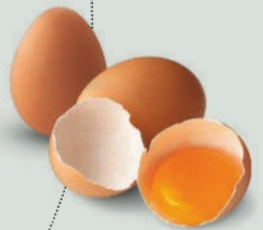
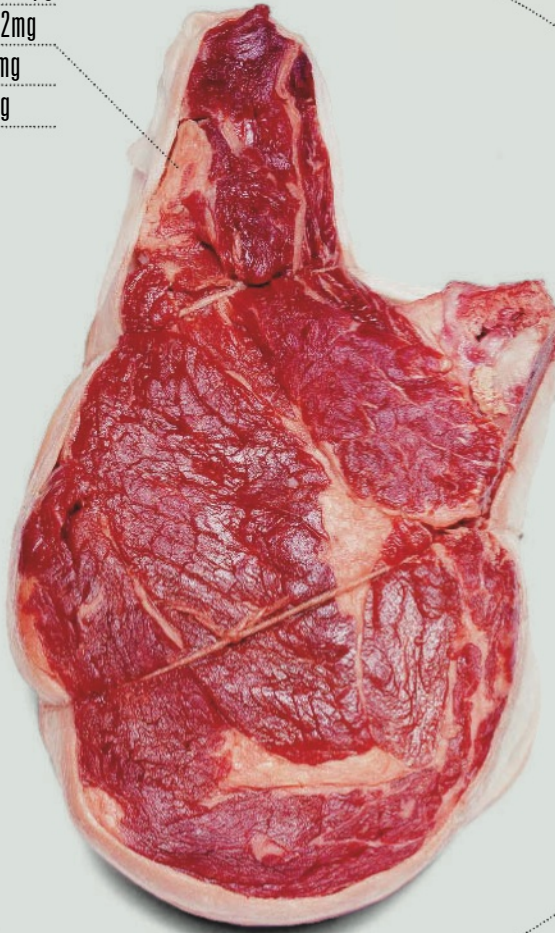
200g

1.5 salmon fillets
Cals - 364
Vit B12 - 6.1µg
Vit B6 - 1.9mg
Iron - 2mg
Sat fat - 2.5g



240g

200 almonds
Cals - 1390
Vit B12 - 0
Vit B6 - 0.3mg
Iron - 9mg
Sat fat - 9g



522g

9 medium eggs
Cals - 566
Vit B12 - 3.5µg
Vit B6 - 0.7mg
Iron - 7mg
Sat fat - 12.4g

600g

1.5 cans kidney beans
Cals - 762
Vit B12 - 0
Vit B6 - 0.7mg
Iron 13mg
Sat fat 0.4g



75g

dried crickets
Cals - 341
Iron - 4.7mg



Recommended daily allowances for women/men: calories 2000/2500, iron 18mg/8mg, saturated fat 22g/28g, vitamin B12 2.4 µg, vitamin B6 1.3mg

different kinds of meat, for example.

Some of the most recent, large-scale research that does take these factors into account has found little or no connection between meat consumption and cancer or heart disease. In 2013, results emerged from two such studies. One was the EPIC trial, which followed half a million people in 10 European countries over 12 years, and as well as distinguishing between consumption of red meat, white meat and processed meat, it also controlled for factors such as smoking, fitness, body mass index and education levels, all of which might be correlated with high meat consumption.

Red alert

The study found no association at all between fresh red meat and ill health, but the link with processed meat remained. It found that for every 50 grams of processed meat people consumed each day, their risk of early death from all causes increased by 18 per cent (see also page 32). And a US study of almost 18,000 people taking part in the National Health and Nutrition Examination Survey (NHANES) found no association between deaths from cancer or cardiovascular disease and the consumption of meat – even processed kinds.

The NHANES findings were surprising, says Sabine Rohrmann of the University of Zurich, Switzerland, who was involved in both NHANES and EPIC. “It was an outlier, because most studies have shown an association.” One explanation could be that the dietary questionnaire used in NHANES was too crude. It didn’t ask people about portion sizes, simply how often they consumed red meat, so people who said they frequently ate meat might only have been eating small amounts.

On the other hand, there could genuinely be no association between meat consumption and deaths in this population. “At this stage, I don’t think we have enough evidence to say that people should avoid meat,” says Rohrmann. “It’s an important food, it contains B vitamins, iron, zinc and other minerals and micronutrients. But meat consumption shouldn’t be too high.”

Contrary to the advice being dished out by the WCRF, based on her findings she wouldn’t advocate abstaining from processed meats, at least until more data is available: “My recommendation would also be to limit it.”

Even those singing the praises of meat agree with the idea of cutting down on the processed forms. But for fresh meat, they also point to

RED MEAT CAN BE GREEN

Make no bones about it, current global meat consumption is a disaster for the environment, and still consumption is rising in many developing nations. As much as 32 per cent of greenhouse gas emissions come from rearing livestock, a third of the world’s cultivated land is used to grow animal feed, and it takes 15,500 litres of water (a small swimming pool) to produce 1 kilogram of beef. But eliminating meat – or substituting beef for chicken or pork – isn’t necessarily the greenest option.

“There’s this view that meat is vile from an environmental perspective, but there’s lots of pastureland around the world that can’t be used to grow crops, and if it’s grazed properly it could be grazed forever. We can’t digest that cellulose, but cows and sheep can,” says Vaclav Smil of Manitoba University in Winnipeg, Canada, author of *Should We Eat Meat?* The same goes for crop residues, such as the straw and bran from grain. Smil calculates that if we used only sustainable grazing and fed livestock on crop residues, we could still raise about two-thirds of the meat we do now.

Grazing cattle and sheep also contribute to biological diversity and are often vital components of rural livelihoods and communities, says Vicki Hird, senior campaigner for land, food and water at Friends of the Earth in London. Chicken and pork produce fewer greenhouse gases, but these animals eat grain and other sources of protein that could be eaten by people instead. “The evidence makes clear that we really just need to eat less meat, and better,” Hird says.

the turning tide of evidence around saturated fat, once viewed as public enemy number one. Its supposed heart-harming effect was one of the reasons people were told to cut meat consumption in the 1970s. But recent studies hint that saturated fats aren’t as bad for the heart as previously thought. There are numerous benefits from eating fresh meat too, they say, not least as the most readily available source of dietary iron.

Besides, over the last few decades, cuts of beef have become much leaner. More than 60 per cent of beef cuts now meet the US government guidelines for lean meat,

“People who eat no meat at all are at higher risk of early death”



FRANK DUENZ/DPA/CORBIS



MARTIN PARR / MAGNUM PHOTOS

says Shalene McNeill, a nutritionist at the National Cattlemen’s Beef Association in Denver, Colorado.

Ironically, though, it’s the iron-rich component in unprocessed red meat, rather than its fat content, which is now generating concern. For a long time, Corpet had been trying to understand why in his studies it was only red meat that seemed to induce pre-cancerous changes in the bowels of mice; poultry didn’t, and fish even seemed to be protective. Then he realised the thing that makes red meat stand out from the rest: haem.

Haem is the iron-rich, non-protein component of haemoglobin – the substance that carries oxygen around in blood, and it is what gives meat its red colour. To test whether haem could be the missing link, Corpet added powdered haemoglobin to rats’ food. “It had the same effect as feeding them beefsteak – it promoted tumour growth,” he says. Chicken,



How do you eat yours? Eating less meat, but of a higher quality, is good for your health and the environment

which contains very little haem, did not.

Haem seems to produce carcinogenic molecules by oxidising fats it comes into contact with – both in the meat, and in vegetable oils. “Even if I eat a very lean red meat like liver, the haem will oxidise whatever fat I have in my salad dressing, for example,” says Corpet.

Other problems could arise not from the meat itself, but how it reacts with microbes in the gut to produce potentially artery-clogging compounds (see page 32). The way we cook meat could also make a difference. Barbecuing and frying it could contribute to ill health, since charring produces carcinogenic compounds, and some people might be more susceptible than others. For instance, smokers with certain genetic mutations are at greater risk of colorectal cancer if they eat a lot of well-cooked meat compared with non-smokers eating the same amount.

So if even fresh, lean meat might be risky, is there any reason to eat the stuff, besides it being tasty?

The nutritional components of meat can certainly be obtained from other sources, even if it's more of a challenge. For example, essential amino acids are found in small quantities in foods such as peas and rice. Even so, the evidence goes against cutting out meat altogether. Perhaps the most surprising finding from the EPIC study was that those

who ate no meat at all had a higher risk of early death from any cause than those who ate a small amount of red meat. “What we see from studies is that people who eat small amounts of meat are as healthy, or maybe healthier, than vegetarians,” says Rohrmann.

Cold potato

Why is that? For a start, vegetarians don't always make healthy food choices. And it's true that because meat has a high protein content and contains all the essential amino acids, you need to eat less of it than plant-based foods to get your quota. “In order to get 25 grams of protein from beef you would need to eat around 150 calories' worth,” says McNeill. “You'd have to eat about 550 calories of peanut butter to get the same amount of protein. Even beans, you'd have to eat double the calories.” Reducing, rather than removing, meat from your diet works from an environmental perspective too (see “Red meat can be green”, left).

Indeed, for those trying to lose weight or reduce cholesterol, incorporating a little lean red meat can help you stick to your guns: you're perhaps more likely to keep to your diet because meat is tasty, and the high protein content also makes you feel fuller.

All this goes against the accusation that meat must be fuelling the rise in obesity. What's more, studies have shown that you can reduce cholesterol levels even if you eat lean red meat every day.

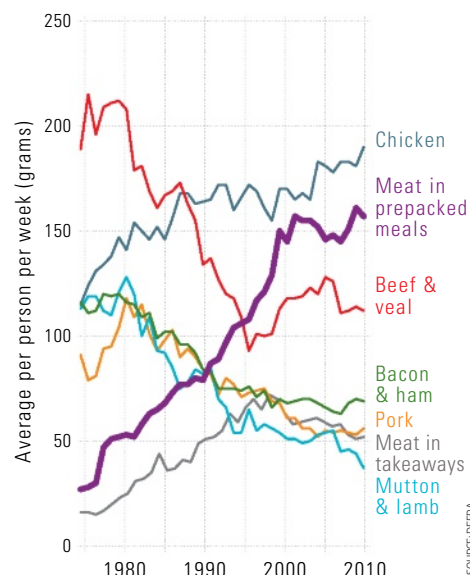
There may also be simple ways to minimise the risks. The EPIC trial found that the early death risk for meat eaters who reported consuming lots of fibre was lower than for



ED KASHI / VII

Meat market

UK consumption of fresh beef and lamb is falling while sales of meaty frozen and chilled meals are going through the roof. Could this adversely affect health?



those who ate very little meat. Similarly, last year, a study found that when people ate cold potatoes with their meat, a certain kind of starch called butyrylated resistant starch, which is produced when potatoes are cooked and then left to cool, seemed to protect them against the DNA damage to gut cells that is associated with colorectal cancer.

Such culinary tweaks could help, but they shouldn't detract from the fact that there do seem to be genuine risks associated with red meat – particularly the processed variety – at least when it is consumed in abundance. “Our recommendation is that you should not eat more than 70 grams red meat per day – which is something like eating a portion two or three times per week,” says Norat. Whether it's better to eat a little meat each day or to save up your credits for a weekend steak splurge remains unclear.

You might try introducing meat-free Mondays into your week, pledging not to eat any meat or dairy food after 6 pm; or trying to use meat just for flavouring, rather than as a key ingredient in meals. As for how you eat it, it seems we had it right all along: go for fresh meat and two veg, just make sure it's not chargrilled. And while you're at it, don't forget potatoes are a dish best served cold. ■

Linda Geddes is a consultant for *New Scientist* based in Bristol, UK

What makes an ordinary person risk their life for a stranger? Michael Bond delves into their stories to find out

We could be HEROES

IT TOOK Michael McNally about 10 seconds from hearing the crash to run from his house in the Cape Cod village of Marstons Mills to the road outside. When he got there, the car was already burning, its front end bent around a tree. Things were exploding in the engine compartment. He looked inside and saw a young woman in the passenger seat. She was about the same age as his daughter. It was clear that if she stayed there another minute she would die.

McNally, 51, reached in through the passenger window and tried to pull her out. He lost his grip, so he repositioned himself through the back seat window and pulled her through by her ankles. "The poor girl was on fire," he says. "Her skin was coming off. It was a horrible thing to see." She was severely burned, but survived.

If you want to know why anyone would risk their life to save a stranger, the last person you should ask are the heroes themselves. Whether running to a burning car or sheltering someone from secret police, usually the protagonists cannot explain why they acted the way they did. "I don't know why I did it," says McNally. "I only know that I did. I just had to act."

It's a familiar story to Walter Rutkowski, president of the Carnegie Hero Fund Commission, which awards medals to

American and Canadian civilians who risk their lives to save others – McNally was given one last year. The usual explanation, he says, is that there is no explanation. "We have more or less settled into the knowledge first expressed by our founder Andrew Carnegie in 1904: heroic action is impulsive."

Compelling stories

This impulsiveness, this apparent unpredictability, is the mystery of heroism. Like all good mysteries it has inspired a host of investigators. For many, their interest in the subject is as much personal as academic: their own stories are often as compelling as those of their subjects.

One such investigator is Samuel Oliner, a sociologist at Humboldt State University in Arcata, California. In June 1942, when he was 12, the Nazis ordered his family to move from their home in the village of Bielanka, southern Poland, to a Jewish ghetto in a nearby town. Early one morning two months later, Nazi soldiers entered the ghetto and ordered everyone into the street. Oliner's stepmother, sensing what was about to happen, pleaded with him to run. So he hid on the roof while the soldiers herded his family and their neighbours into trucks, drove them into a nearby forest, and killed them.

"Impulsiveness and unpredictability are the great mysteries of heroism"





Oliner eventually left his hiding place and headed into the countryside. After three nights sleeping rough he knocked on the door of a Catholic woman, Balwina Piecuch, who had known his family before the war. At great risk to herself and her family, she took him in, helped him create a false identity and hid him from the Gestapo. Oliner is fond of saying that her act of kindness not only saved his life, it also shaped his life. After the war he emigrated to the US, entered academia and dedicated his career to understanding the selfless motivation of people like her.

Altruism has long been an evolutionary mystery. Why would anyone choose to help somebody not related to them, with no promise of reward? The usual answer is that such behaviour is an adaptation: for example, groups in which it emerged would have been more cohesive, and hence more successful. But what about acts of extreme altruism? Can we ever understand why some people risk – and sometimes lose – their lives for a stranger?

To try to answer this question, Oliner and his wife Pearl set up the Altruistic Personality and Prosocial Behavior Institute at Humboldt

State University in 1982. In one of their first studies, still the largest of its kind, they interviewed and psychologically assessed 406 people who had risked their lives to rescue Jews in Nazi-occupied Europe, along with 72 people who had lived in occupied areas but had done nothing out of the ordinary. A number of things became clear. The rescuers were much more empathic than the non-rescuers, and they also espoused values of fairness, compassion and personal responsibility towards strangers that they said they had learned from their parents. ➤

What's more, they were unusually tolerant: the people they identified as their "in group" consisted of the whole of humanity, not just their own kind. As Kristen Monroe at the University of California, Irvine, who has studied the psychology of Holocaust rescuers, puts it: "Where the rest of us see a stranger, an altruist sees a fellow human being."

Samuel Oliner says this finding has held up in all their subsequent studies. It has also been replicated by psychologist Eva Fogelman, whose father, too, owed his wartime survival to the generosity of Polish peasants. Fogelman has spent much of her career studying the psychological effects of the Holocaust on survivors and their families. In her book *Conscience and Courage*, she recalls her conversations with about 300 rescuers of Jews: "I began after a while to wait for the recital of one or more of those well-known passages: a nurturing, loving home; an altruistic parent or beloved caretaker who served as a role model for altruistic behavior; a tolerance for people who were different."

Further research has added weight to the idea that some people are more predisposed than others to help. In one recent study, David Rand of Yale University and his colleagues got volunteers to play a series of cooperation and punishment games often used in experimental economics (see diagram, opposite). They found that people who cooperate in one game tend to cooperate in all, and also help out for real when offered a chance to do so, even when there is nothing in it for them. "The basic motivators that make you want to help people apply across a lot of different domains," says Rand.

Where do these motivators come from? In keeping with the Oliners' findings, cooperators are more likely to hold egalitarian values and be strongly influenced by their parents' altruism. A series of recent studies also suggest that altruistic behaviour is seeded in young children's early social interactions with adults.

There also appears to be a biological component – although whether this is inherited or acquired is not known. Neuroscientists led by Abigail Marsh at Georgetown University in Washington DC found that people who had volunteered to

"Where the rest of us see a stranger, an altruist sees a fellow human being"



Tugce Albayrak was killed in November defending two girls from harassment in Frankfurt, Germany

donate a kidney to a stranger had larger and more responsive right amygdalae than normal. This area of the brain helps us recognise fearful facial expressions, something altruists and those high in empathy are adept at. Many studies have shown that people who are better at recognising fear in others are more likely to help them. The right amygdala is also notably reduced in psychopaths, who are spectacularly bad at recognising or responding to fear.

All this points to what Samuel Oliner calls an "altruistic personality" – a set of stable, lifelong traits that consistently orientate some people towards altruistic behaviour.

Rand is now grappling with the million-dollar question: does having an altruistic personality make someone more likely to risk their life to save a stranger? He thinks impulsive heroes are indeed motivated by their personality, though this is hard to test because people rarely get the opportunity to

be heroic more than once. This infrequency is a major barrier to understanding extreme altruism. Since heroes are heroes perhaps once in a lifetime, and their heroism figures prominently in the story of their lives thereafter, it is tempting for them to rewrite their personal narratives – particularly when questioned by researchers. "If you put your life on the line for someone you don't know, most people would want a narrative to help them make sense of the massive risk they've taken," says Frank Farley, who studies risk-taking and heroism at Temple University in Philadelphia.

One thing seems clear, however: heroism is intuitive. It couldn't be any other way, says Rand, because most people who find themselves in high-stakes situations are completely unprepared. This is borne out by another of Rand's studies. He examined the testimonies of 51 Carnegie heroes to try to understand how they decided to risk their

lives. In line with Carnegie's hunch, he found overwhelmingly that their actions were intuitive rather than deliberative. Even when they had time to reflect on what they were about to do, they did not.

Take this typical response, from 60-year-old lawyer Kermit Kubitz, who in 2007 intervened to protect a 15-year-old girl from a knife attack and ended up being stabbed himself: "I think it was just instinct." And recall McNally's 10-second dash to the burning car. "I didn't really have time to think," he said. Or perhaps he chose not to.

Default setting

Rand believes our reaction at such times reflects the way we usually behave in more familiar, low-stakes scenarios. So if someone is accustomed to acting altruistically on a daily basis, they are more likely to do so when the risks are high, because this is their default behaviour. Extreme altruism, then, is just that: an extreme form of "ordinary" altruism. But, Rand says, this doesn't mean it is adaptive. Instead, it is a misapplication of an impulse to be generally helpful to others.

He also acknowledges that although altruism is necessary for heroism, it isn't sufficient. "If you were to put that same person in the same situation, we don't know how often they would risk their life. They need to be in the right internal state."

Farley agrees that an altruistic personality alone does not make heroes. You also need a propensity for risk-taking or thrill-seeking, known as a Type T personality, he says. "If you are a T Type without altruism, you may take a pass. If you are altruistic but risk-averse, you may also take a pass."

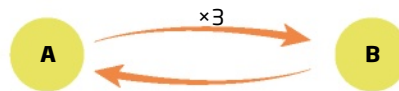
How often these personality traits come together is not known, but heroic acts are not all that unusual. In its 110 years the US Carnegie fund has awarded almost 10,000 medals, around 90 per cent of them to men, and 20 per cent posthumously to people who died in their act of heroism. Its sister organisations in Europe have awarded thousands more.

Further understanding has come from studying war heroes. Heroism in battle is a little different from extreme altruism because soldiers' heroic acts are almost always inspired by loyalty to comrades rather than compassion towards strangers. Perhaps not surprisingly, then, war heroes don't seem to share personality traits in the same way that extreme altruists do. A study of 283 Israeli soldiers awarded medals for bravery during

Search for the hero inside

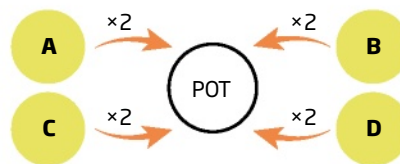
People with an "altruistic personality" are more likely to cooperate in laboratory games like these – and more likely to act heroically in real life. In each game a point is worth 1.5 cents in real money. The object is to finish the game with as much money as possible

TRUST GAME



A starts with 50 points, and decides how many to donate to **B**. The donation is then tripled, and **B** decides how much to return to **A**

PUBLIC GOODS GAME



Participants each start with 100 points and must decide how much to contribute to the pot. Their contributions are doubled and split four ways

ULTIMATUM GAME



A starts with 100 points and secretly decides how much to offer to **B**, up to 50. **B** then announces the minimum acceptable offer. If **A**'s offer is lower, both get nothing

the 1973 Yom Kippur war found no personality traits that set them apart from other soldiers.

However, it is possible that they share traits or histories that have not been picked up due to a lack of biographical data. Diddy Grahame, who as secretary of the Victoria Cross and George Cross Association in London is familiar with the histories of hundreds of decorated heroes, says that a disproportionate number are older siblings from a large family, sons of widowed mothers, or had other early life experiences that gave them a habit of caring and taking responsibility.

This has not been confirmed by academic research, but if it is correct, war heroes have much in common with civilian ones. McNally, reflecting on his rescue mission, revealed that

he had been a helper all his life, caring for his mother after the death of his father.

Despite the indications that altruistic behaviour comes more naturally to some people than others, many researchers in the field are convinced that it can be taught. "While the biological predisposition should not be neglected, there is no doubt in my mind that people can be primed to change their position from bystander to helper," says Samuel Oliner. He says the best chance is during childhood, and that school curricula should include programmes aimed at instilling altruistic values.

It is also possible in adulthood, says Ervin Staub, a psychologist at the University of Massachusetts at Amherst, who has spent much of his career trying to achieve just that. Like so many others, the seeds of his academic mission were planted during the second world war. His family was among thousands of Hungarian Jews who were sheltered from the Nazis by the Swedish diplomat Raoul Wallenberg. For three decades, Staub has been testing what he calls "active bystandership" – the capacity of people who may not be naturally heroic to help those in distress.

Staub worked with California's department of justice following the beating of Rodney King by Los Angeles police in March 1991, encouraging officers to break ranks and speak out. Since 1998, he has been promoting reconciliation in Rwanda. One of his successes there is an educational radio drama designed to teach people about the causes of conflict and how to resolve it, which he says has engendered more positive relations between ethnic and social groups and led to a greater appetite for reconciliation. He has also established a programme in Massachusetts to help schoolchildren challenge bullies, which can require considerable courage.

Two years before Carnegie established the hero award, his friend Silas Weir Mitchell, one of the founders of neurology, wrote a magazine article called *Heroism in Every-Day Life*. "Men are in emergencies the puppets of their past, which of a sudden pulls the unseen wires and determines action," he wrote. "The gun was loaded long ago: occasion pulls the trigger."

That article may have inspired Carnegie to set up his fund. Fortunately for humanity, we now know that neither man got it entirely right. Heroes do not act entirely out of the blue, and it is never too late to load that gun. ■

Michael Bond is a *New Scientist* consultant based in London. This article is based on a chapter in his book *The Power of Others*



FUNNY FEET

Human feet are far more varied than we thought and - no offence - yours are weird, says Laura Spinney



GALLERYSTOCK

MY RUNNING shoes have a thick sole and cushioned heel. I bought them five years ago, before the “barefoot” craze for minimalist shoes that would allow people to better emulate how our ancestors ran. Soon after that, reports began appearing of injuries sustained by runners who had adopted these shoes, and lawsuits were filed against some manufacturers. Now the maximally cushioned or “fat” shoe is back in vogue, and suddenly my old shoes look high-tech again.

Is all this simply a matter of fashion, I wonder, or is it telling us something more profound? Surprisingly, we are only beginning to discover what a normal human foot looks like, how it should move, and the role that shoes play. Recent research, sparked in part by the fallout from barefoot running, reveals enormous diversity in healthy feet. What’s more, the average Western foot turns out to be an outlier, deformed with respect to our ancestors’ feet and those of our barefoot contemporaries. Much of this is down to shoes, which have taken over some of the work our feet had to do to allow us to become bipedal. “We assume that the people around us are normal, but from an evolutionary perspective, they’re not,” says evolutionary biologist Daniel Lieberman at Harvard University.

The anatomy of the human foot is no mystery. It is a complex structure, containing 26 bones and over 100 muscles, tendons and ligaments. It is also malleable, as will be obvious to anyone who has seen photos of young women’s feet bound according to a gruesome old Chinese custom, ostensibly to make them dainty. Some victims wound up with feet that looked as if they had inbuilt high heels.

Foot shape is the product of gene-environment interactions, but how do they play out? Until recently, the few studies there were had focused almost exclusively on Westerners – which, in practice, meant people who had worn shoes since they could walk. Lieberman and his colleagues were among the first to cast their net more widely. In a study published in 2010, they found that Kenyan endurance runners who had grown up without shoes landed more often on their toes than on their heels as 80 per cent of shoe-wearing distance runners do. The work helped to trigger the barefoot running craze, but Lieberman points out that the sample size was small and that the results didn’t support many of the claims later made for barefoot running, such as the idea that it reduces the risk of injury. However, the hint that wearing shoes could have such a big impact on how we use ➤



CINDERELLA'S LEGACY

"Things started to go wrong in the 16th century," says Marquita Volken, a shoe archaeologist who runs the Shoe Museum in Lausanne, Switzerland. It was then that European streets began to be paved and the soles of shoes began to get thicker to cushion urban feet. Influenced by the vagaries of fashion, heels rose and both men and women were soon tottering on platforms up to half a metre high. These were the peacock's tail of footwear, a showy badge of social superiority, says Kristiaan d'Août of the University of Liverpool in the UK - since there was no way the wearer could work in them.

The French Revolution brought everyone back down to earth, and when heels started rising again the trend only affected women's shoes - probably, d'Août suggests, because they exaggerated the female aspects of gait. A recent study hints this could have benefits. It showed that men's (but not women's) helpfulness towards a woman was correlated with the height of her heels (*Archives of Sexual Behavior*, DOI: 10.1007/s10508-014-0422-z).

High heels are not good for feet, however, especially when shoes also constrict the toes. Studies of premodern European skeletons suggest that hallux valgus - the condition commonly known as the bunion - started to become prevalent in the 16th century, and has never been more common in women than it is now. A 1993 survey of American women showed that 88 per cent wore shoes that were too small for them, 80 per cent reported pain, and 76 per cent had some sort of foot deformity, bunions being the most common (*Foot & Ankle*, vol 14, p 78). "Shoe design is cyclical," says Volken, whose new book *Archaeological Footwear* chronicles the development of shoes from prehistory to the 1600s. "We're currently in an unhealthy phase."

"Three-quarters of women reported having some sort of foot deformity"

our feet was intriguing, and Lieberman and others have pursued its implications.

A team led by biological anthropologist Kristiaan d'Août, then at the University of Antwerp, Belgium, also did pioneering work in this area. In 2009, they measured the feet of 70 Indians who didn't wear shoes and compared them with those of 137 Indian and 48 Belgian shoe-wearers. They also asked all three groups to walk on a pressure-sensing treadmill, which generated dynamic pressure maps of the foot as it hit the ground.

The barefoot walkers tended to have relatively wide feet, with pressure fairly evenly distributed over the parts touching the ground when walking. The shoe-using Indians had narrower feet and a less even pressure distribution. But the Belgians, who wore more constricting shoes, more often than the shoe-wearing Indians, had very different feet: relatively short and slender, with pressure hotspots at the heel, big toe and midfoot region of the metatarsals (see diagram, right).

Floppy feet

The researchers concluded that shoe-wearing is one of the most powerful environmental factors influencing the shape of our feet (*Footwear Science*, vol 1, p 81). It can also have a big impact on the way we walk, as anthropologist Jeremy DeSilva and gait expert Simone Gill, both at Boston University, discovered. They persuaded nearly 400 adult visitors to the Boston Museum of Science to walk barefoot over a 6-metre-long "gait carpet", which measured speed and stride length as well as building pressure maps. This revealed something remarkable. Around 1 in 13 people were extraordinarily flat-footed: they had a pressure hotspot resulting from their midfoot moulding to the ground as they walked. "Their feet were as flexible as chimps," says DeSilva (*American Journal of Physical Anthropology*, vol 151, p 495).

As humans evolved to be bipedal, our feet developed longitudinal and transverse arches. These created rigidity in the central part of the outside of the foot, to help propel us forward when we lift our heel and push down on the ball of the foot. In other words, a rigid midfoot is a signature of bipedality. Chimps lack this rigidity, their feet being floppier in the middle to allow them to grip a branch. In technical terms, they have a "midtarsal break", and it's this that DeSilva and Gill observed in some museum visitors. Since publishing their finding in 2013, they have ruled out the possibility that the midtarsal break runs in families. In other words, it isn't strongly

"Around 1 in 13 people were extraordinarily flat-footed. Their feet were as flexible as chimps'"

heritable, although a predisposition to it could be. Instead, DeSilva suspects that it is mainly a result of wearing shoes. "The shoe provides the rigidity, in a way, so the foot doesn't have to," he says.

Two studies published by Lieberman and colleagues last year seem to back this conclusion. In one, they looked at the feet of Tarahumara Native Americans in Mexico – famed endurance runners whose traditional sandals inspired minimalist running shoes – and found that those who ran in sandals had stiffer arches than those who ran in conventional shoes (*Journal of Sport and Health Science*, vol 3, page 86). The other study showed just how quickly feet can adapt. After 12 weeks of regular running in minimalist shoes, Western runners developed significantly stiffer arches.

What goes on within our feet as we walk is still a bit of a mystery. The pressure map method can only give an indirect measure of the mechanics involved. But a novel technique pioneered by Paul Lundgren at the Karolinska Institute in Stockholm, Sweden, and colleagues, takes things a step further. They surgically implanted metal pins into nine bones in the feet of six volunteers, and capped the protruding ends with reflective markers that could be tracked using motion-capture cameras. The technique revealed that all the joints in the foot and ankle contribute to the way we walk, the movement of each joint being dependent on the others (*Gait & Posture*, vol 28, p 93). It also showed great diversity among individuals in the range of movement of each joint – especially in the midfoot.

A team at the University of Liverpool, UK, led by Karl Bates, has replicated that finding in a group of 45 volunteers, using pressure maps. Their study also included bonobos and orangutans, revealing the pressure of human footfalls to be as diverse as those measured in these most arboreal of apes. "What the bone-pin study showed is that everybody is different," says Bates. "For some people the foot is stiff, but for others there is actually a surprising amount of movement."

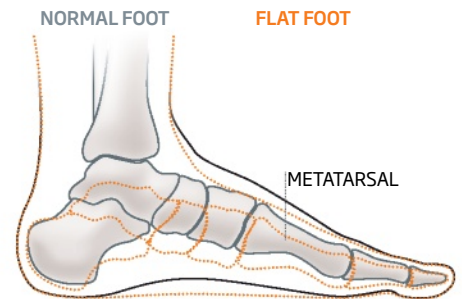
This natural variation raises important questions. First, if "normal" covers such a wide range, what is an abnormal foot? In the past, foot disorders have been defined as much by social concerns as by medical ones. For example, flat feet were regarded as a sign of moral flabbiness in the American character, according to medical historian Beth Linker of the University of Pennsylvania, Philadelphia, (*Social History of Medicine*, vol 20, p 91). During the first world war, a soldier could be invalidated out of the US army for flat feet – but not for shell shock – and flat-foot camps, designed to rehabilitate the afflicted, spread across the country.

Doctors also have misconceived ideas about feet. "The human foot is supposed to be very stiff, and if it's not then often a clinical problem is diagnosed," says Bates. But he and others have shown that flat-footedness isn't necessarily associated with pain or any radical restriction of function. None of the flexi-footed visitors to the Boston Museum of

Born to run: do stiffer arches give Tarahumara runners the edge in ultramarathons?

Shaped by our shoes

Wearing shoes could be making our feet narrower and bendier, especially in the midfoot and around the metatarsals – making some people more prone to developing flat feet



Science complained of pain. And although DeSilva suspects that people with mobile midfeet may not figure among the fastest runners, because they have less elastic recoil when they push off the ground, they pay no obvious price in terms of health.

Bates believes the new findings should also change the way we interpret hominin fossils, because the bones of one individual may tell us little about how its foot worked, let alone how other members of the species walked. Take Lucy, the famous 3.2 million-year-old australopithecine unearthed in Ethiopia, who carries all the hallmarks of bipedalism. When DeSilva compared her ankle bones with X-rays of modern human feet, he concluded that she was probably flat-footed in a non-pathological way. It's hard to say how typical of her kind she was, though. "There would have been variation in her species as in ours, but perhaps around a different norm," he says.

We still have much to discover about what normal means when it comes to feet but one thing is clear. Although going barefoot was normal for most of human evolution, our relatively short period of footwear use – about 40,000 years, according to the archaeological record – has left its mark. That's largely because the human foot turns out to be so plastic. This finding, in turn, holds hope for anyone wanting to turn back the clock. We may be able to run more like our ancestors if we take it gradually, realising that in donning minimalist shoes we load our bodies differently, and that the surfaces we run on are quite different to what they coped with. Nevertheless, the jury is still out as to whether barefoot shoes bring better performance or fewer injuries. Until it delivers its verdict, I'll be hanging on to my old running shoes. ■

Laura Spinney is based in Lausanne, Switzerland



MARCOS FERRO/AURORA PHOTOS/AURORA PHOTOS/CORBIS

Conscious awakening

Ex Machina is a better film for its engagement with current theories about the meaning of consciousness, finds neuroscientist **Anil Seth**

IT'S a rare thing to see a movie about science that takes no prisoners intellectually. Alex Garland's *Ex Machina* is just that: a stylish, spare and cerebral psycho-techno-thriller, which gives a much-needed shot in the arm for smart science fiction.

Reclusive billionaire genius Nathan, played by Oscar Isaac, creates Ava, an intelligent and very attractive robot played by Alicia Vikander. He then struggles with the philosophical and ethical dilemmas his creation poses, while all hell breaks loose.

Many twists and turns add nuance to the plot, which centres on the evolving relationships between the balletic Ava and Caleb (Domhnall Gleeson), a hotshot programmer invited by Nathan to be the "human component in a Turing test", and between Caleb and Nathan, as Ava's extraordinary capabilities become increasingly apparent.

Everything about this movie is good. Compelling acting (with only three speaking parts), exquisite photography and set design, immaculate special effects, a subtle score and, above all, a hugely imaginative screenplay combine under Garland's precise direction to deliver a cinematic experience that grabs you and never lets go.

The best science fiction often tackles the oldest questions. At the heart of *Ex Machina* is one of our toughest intellectual knots, that of artificial consciousness. Is it possible to build a machine that is not only intelligent but also sentient: that has consciousness, not only of the

world but also of its own self? Can we construct a modern-day Golem, that lumpen being of Jewish folklore which is shaped from unformed matter and can both serve humankind and turn against it in certain conditions? And if we could, what would happen to us?

The acid test

Putting aside the tedious business of actually building a conscious AI, we face the challenge of figuring out whether the attempt succeeds. The standard reference for this sort of question is Alan Turing's eponymous test, in which a human judge interrogates both a candidate machine and another human. A machine passes the test when the judge consistently fails to distinguish between them.

While the Turing test has provided a trope for many AI-inspired movies (such as Spike

Jonze's excellent *Her*), *Ex Machina* takes things much further. In a sparkling exchange between Caleb and Nathan, Garland nails the weakness of Turing's version of the test, a focus on the disembodied exchange of messages, and proposes something far more interesting. "The challenge is to show you that she's a robot. And see if you still feel she has consciousness," Nathan says to Caleb.

This shifts the goalposts in a vital way. What matters is not whether Ava is a machine. It is not even whether Ava, even though a machine, can be conscious. What matters is whether Ava makes a conscious person feel that Ava is conscious. The brilliance of *Ex Machina* is that it reveals the Turing test for what it really is: a test of the human, not of the machine. And Garland is not necessarily on our side.

Is consciousness a matter of social consensus? Is it more relevant whether people believe (or feel) that something (or someone) is conscious than

Nathan (left) and Caleb struggle over their feelings about AI Ava



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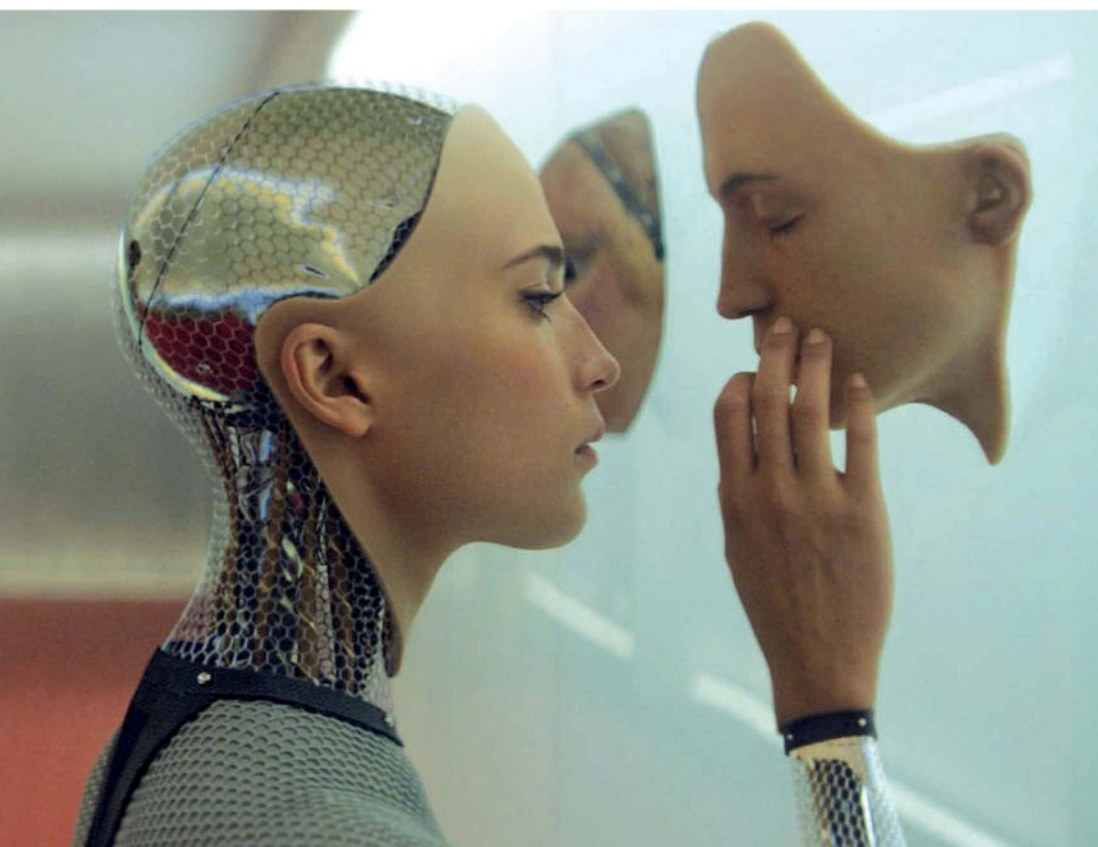
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Ava, the most advanced AI, is an eerie mixture of robot and woman

whether it is in fact actually conscious? Or, does something being "actually conscious" rest on other people's beliefs about it being conscious, or on its own beliefs about its consciousness (beliefs that may themselves depend on how it interprets others' beliefs about it)? And exactly what is the difference between believing and feeling in situations like this?

It seems to me that my consciousness, here and now, is not a matter of social consensus or of my simply believing or feeling that I am conscious. It seems to me, simply, that I am conscious here and now. When I wake up and smell the coffee, there is a real experience of coffee-smelling going on.

But let me channel Ludwig Wittgenstein, one of the greatest philosophers of the 20th century,



for a moment. What would it seem like if it seemed to me that my being conscious were a matter of social consensus or beliefs or feelings about my own conscious status? Is what it “seems like” to me relevant at all when deciding how consciousness comes about or what has consciousness?

Before vanishing completely into a philosophical rabbit hole, it is worth saying that questions like these are driving much influential current research on consciousness.

Philosophers and scientists like Daniel Dennett, David Rosenthal and Michael Graziano defend, in various ways, the idea that consciousness is somehow illusory and what we really mean in saying we are conscious is that we have certain beliefs about mental states, that these states have distinctive functional properties, or that they are involved in specific sorts of attention.

Another theoretical approach accepts that conscious experience is real and sees the problem as one of determining its physical or biological mechanism. Some leading neuroscientists such as Giulio Tononi, and recently, Christof Koch, take consciousness to be a fundamental property, much like mass-energy and electrical charge, that is expressed through localised concentrations of “integrated information”.

“The film reveals the Turing test for what it really is: a test of the human, not of the machine”

Others, like philosopher John Searle, believe that consciousness is an essentially biological property that emerges in some systems but not in others, for reasons as-yet unknown.

And in the film we hear about Searle’s Chinese Room thought experiment. His premise was that

researchers had managed to build a computer programmed in English that can respond to written Chinese with written Chinese so convincingly it easily passes the Turing test, persuading a human Chinese speaker that the program understands and speaks Chinese. Does the machine really “understand” Chinese (Searle called this “strong AI”) or is it only simulating the ability (“weak” AI)?

There is also a nod to the notional “Mary”, the scientist, who, while knowing everything about the physics and biology of colour vision, has only ever experienced black, white and shades of grey. What happens when she sees a red object for the first time? Will she learn anything new? Does consciousness exceed the realms of knowledge?

All of the above illustrates how academically savvy and intellectually provocative *Ex Machina* is. Hat-tips here to Murray Shanahan, professor of

cognitive robotics at Imperial College London, and writer and geneticist Adam Rutherford, whom Garland did well to enlist as science advisers.

Not every scene invites deep philosophy of mind, with the film encompassing everything from ethics, the technological singularity, *Ghostbusters* and social media to the erosion of privacy, feminism and sexual politics within its subtle scope.

But when it comes to riffing on the possibilities and mysteries of brain, mind and consciousness, *Ex Machina* doesn’t miss a trick.

Scientific straitjacket

As a scientist, it is easy to moan when films don’t stack up against reality, but there is usually little to be gained from nitpicking over inaccuracies and narrative inventions. Such criticisms can seem petty and reinforcing of the stereotype of scientists as humourless gatekeepers of facts and hoarders of equations.

But these complaints sometimes express a sense of missed opportunity rather than injustice, a sense that intellectual riches could have been exploited, not sidelined, in making a good movie. AI, neuroscience and consciousness are among the most vibrant and fascinating areas of contemporary science, and what we are discovering far outstrips anything that could be imagined out of thin air.

In his directorial debut, Garland has managed to capture the thrill of this adventure in a film that is effortlessly enthralling, whatever your background. This is why, on emerging from it, I felt lucky to be a neuroscientist. Here is a film that is a better film, because of and not despite its engagement with its intellectual inspiration. ■

Anil Seth is professor of cognitive and computational neuroscience at the University of Sussex, UK, and co-director of its Sackler centre for consciousness science @anilkseth

The greenest dream

Eco-cities seduce, but more prosaic schemes may have a bigger impact, finds **Fred Pearce**

Fantasy Islands: Chinese dreams and ecological fears in an age of climate crisis by Julie Sze, University of California Press, \$26.95/£18.95

Who Rules the Earth? How social rules shape our planet and our lives by Paul F. Steinberg, Oxford University Press USA, \$29.95/£19.99

THERE are two visions of a greener world: an Arcadian, back-to-the-land version in which we all live simpler, more frugal lives; and a modernist, high-tech version, in which we live in eco-cities, built for us by engineers, architects and real-estate companies.

It is easy to imagine that the Arcadians are the fantasists, but it may be that the pervasive mythology of eco-modernism is really messing with our heads, argues Julie Sze. Her centrepiece for exploring these green urban imaginings is Dongtan city, China.

A decade ago, the bosses of megacity Shanghai set their sights on the east end of Chongming, the world's largest alluvial island, in the mouth of the Yangtze. They planned to cover it with an eco-city of 500,000 people. Dongtan would ban cars, run on biogas and wind, recycle water and surround itself with organic farms, forests and golf courses. It would be a catalyst for greening Shanghai.

A lot of people got caught up in the fantasy. London's then mayor Ken Livingstone and former UK deputy prime minister John Prescott made pilgrimages, dreaming of their own Dongtan outside London. I reported from Dongtan in 2006 for *New Scientist*.

China's project was always part theme park. Its first phase was conceived as the star attraction for the "green" Shanghai World Expo of 2010. But 2010 came and went.



NIRELIAS/REUTERS/CORBIS

Nothing has been built, apart from a giant bridge linking the island to Shanghai. With local champions retired or caught up in an unrelated corruption scandal, Arup, the British architects behind the blueprint, say Dongtan is dead.

Sze's exploration of the official self-delusion and public eco-desires that sustain fantasies such as Dongtan is compelling. Not

least because she has an insider's view of both Shanghai, where her mother was born, and Chongming island, where her father came from. The locals, she reports, were cynical from the first.

Even if it had been built, Sze believes Dongtan would have been as meaningless and artificial as Thames Town, an "authentic British-style small town" built in Shanghai, complete with cobbled streets, little shops, mock-Tudor pubs and a church. The place is popular for wedding photographs but not much else.

Real or imagined, eco-cities are part of the problem rather than the solution, says Sze. They are about real estate rather than real environmentalism. At best, they are the must-have urban accessories of global villains. Hence the emergence of Masdar, a clean-tech mirage in Abu Dhabi's shimmering sands. Even fantasies

Map of Dongtan eco-city (above), and recycling realities (bottom left)

that such places could be key to a green future are manufactured, another form of consumerism.

What Sze's exploration of the narratives of eco-modernism shows well is how flexible the creed of environmentalism can be – and how that quality can be manipulated. What it misses is the upside. Utopias, built or conceptual, have a long tradition of opening minds. We need the freedom to imagine futures, even if they don't happen.

But if you don't buy the idea that architects can change the world, maybe social engineering can, argues political scientist Paul Steinberg. In *Who Rules the Earth?* he analyses how social rules that are often invisible govern huge areas of human activity that really can make a difference to



DAVID ROSE/PANOS

the environment – for good or ill. Moreover, changing those rules “is well within the reach of ordinary citizens... when people join together”.

This is the book for all who have recycled their rubbish, grown vegetables and wondered at the futility of such personal gestures. Like everyone else, green supporters have become too individualistic, says Steinberg. We need collective action to change the social rules.

The thesis sounds dry, but drawing on 20 years of first-hand research into how things get changed, his examples come thick and fast. He starts with a small-town dermatologist in Quebec who, worried about a deluge of skin rashes, persuaded her town

“This is the book for all who have recycled and wondered at the futility of such personal gestures”

council – and ultimately most of Canada – to ban the spraying of pesticides on municipal lawns.

And Steinberg’s brilliantly argued activists’ charter yields a bottom-up approach to greening that is quite at odds with the top-down eco-engineering of Dongtan and Masdar. It takes in property rights, building regulations, international trade laws and freedom of information.

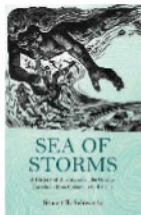
But it is also about unwritten norms of neighbourliness, and the habits and assumptions of businesses that enslave us to unnecessary, uneconomic and environmentally disastrous fossil fuels. All this can be changed, he says. The trick is to find policy catalysts, whether for cutting CO₂ or replanting rainforests, creating dark skies or ensuring access to beaches, cleaning rivers or planting community gardens. For, against all the odds, Steinberg believes that the good guys can rule. And the good guys are us. ■

Fred Pearce is a consultant for *New Scientist*

Turbulent times

Hurricanes cast a long geopolitical shadow, finds **Adrian Barnett**

Sea of Storms: A history of hurricanes in the greater Caribbean from Columbus to Katrina by Stuart B. Schwartz, Princeton University Press, \$35/E24.95



THINK back to when you were a child building cities with your friends out of Meccano or Lego, effortlessly solving engineering

problems. Now marvel in retrospect at how different the resulting bridges, towers or skyscrapers were, even when you all started out with the same kit.

Building Caribbean colonies from scratch in the 16th century must have been similar. How European colonists met the challenges of island life and economy varied greatly, depending largely on the political and social structures they imported from home.

But there was one major difference. Younger siblings

Living through the awful aftermath of hurricanes like Katrina



THOMAS DORZAK/MAGNUM

aside, no one would have knocked down your childhood creations. In the Caribbean, however, there were hurricanes. What happens when they hit, when economies, societies and people are warped, rent or lost entirely, is the subject of Stuart Schwartz’s *Sea of Storms*.

Caused by warm seas and equatorial Coriolis forces, hurricanes were completely outside the European experience. So when 16th-century Spanish colonists were faced with winds that carried church bells and cannons kilometres inland, sank fleets and destroyed whole towns, they considered them manifestations of divine wrath. Later British, French, Dutch and Danish arrivals could only agree.

Following a hurricane in 1772, for example, one poor planter wrote bitterly: “In vain are all our schemes if the hand of providence interferes to blast our hopes... we tremble in the face of danger and call upon Him for succour who alone can protect us.”

Using the abundant archive material sent home by plantation owners, sea captains and civil and military administrators, Schwartz

shows how this providential point of view gradually changed. Curiosity crept out from under the duvet of religion, barometers and thermometers became available – and the culture of scientific quantification and explanation became acceptable.

Schwartz details the lives and achievements of meteorological luminaries such as William Reid, a British lieutenant-colonel, and William Redfield, an American former harness-maker. Together, Reid and Redfield worked through the evidence to discover how hurricanes work. Shortly after, Jesuit priest Benito Viñes used this knowledge and the newly invented telegraph to create the first Caribbean-wide storm-warning service.

Schwartz’s finely researched work also shows how difficult it must have been to be a colonial administrator: when all communication went by sea, a reply to an urgent request for funds could take eight months.

There was also the delicate act of balancing what the Crown wanted against what the settlers considered their due, what creditors insisted on and what the slave population threatened. Hurricanes regularly sundered this balance, and Schwartz explores how this brought out the best and worst in people at all levels of society. With its long, historical perspective this fascinating story shows how hurricane Katrina’s recent racial divisions, individual heroisms and official finger-pointing are far from unique events. ■

Adrian Barnett is a rainforest ecologist at Brazil’s National Institute of Amazonian Research in Manaus

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Promoting Innovation in Science and

Mathematics: Awards provide teachers with funding for materials, equipment, and training to conduct hands-on, inquiry-based science and mathematics projects in North Carolina public schools.

The Burroughs Wellcome Fund is a private foundation
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Why we yawn

From Chris Good

Simon Thompson's claim that yawning is associated with brain warming seems to be pure speculation (20/27 December 2014, p 38). When offered a hot towel during flying, I always applied it to my forehead, but it never made me start to yawn.

Applying moderate heat or cold to the head is unlikely to alter brain temperature as the organ is not only protected by our thick skull, but by three membranes and cerebrospinal fluid.

In addition, the scalp's blood supply and that of the brain are almost entirely separate, so measuring the temperature of the top of the head is no guide to that of the brain.

When performing surgery on the brain we used to have to chill the whole body to reduce the brain temperature. It would have been much simpler and safer to have cooled just the head, if that were possible.

Likewise, I never observed a conscious patient yawn during thermo-coagulation for treatment of Parkinson's disease, where brain tissue is heated with a needle electrode. Nor am I aware that patients with sunstroke start yawning.

Contagious yawning probably occurs through the action of our so called mirror neurones. Did so much unfounded speculation make me yawn? No – it made me write this rebuttal!

Thicket Grove, Berkshire, UK

From Natasha Long

Simon Thompson suggests that people with autism aren't as prone to contagious yawning as other people are because they can't recognise facial expressions.

Yawning is not the sort of subtle facial expression that some autistic people may find hard to read. As Thompson writes, studies have shown that contagious yawning is related to how close we feel to the yawner.



It's much more likely that people with autism don't show a strong yawn response because they don't feel an emotional connection to the yawner. Logic is the order of the day for us.

Brighton, UK

Lawyers' limits

From Shane Budden

As a trial lawyer of more than 20 years' experience, I was interested to read about linguist Alan Yu's research regarding the effect of a lawyer's voice on court judgments (3 January, p 12).

However, it seems that Yu has missed one very important factor: the relative merit of each case. We lawyers do, of course, bring something to the table in legal proceedings, but no matter how skilled we are, it is a simple fact that some cases are far less winnable than others.

Given that the US Supreme Court hears appeals on matters already determined, success will rely on showing that the lower court's decision was infected with error – or that it wasn't, if the respondent is to be successful.

Even the most skilful advocate cannot show error where there is none, nor hide errors that are there, no matter what tone of voice he or she uses.

Jury trials are of course quite different, and the best lawyers are skilled people-readers who can alter their tone, manner of speaking and many other variables to suit the jury before whom they

are appearing; judges, however, are not so easily manipulated.

Kenmore, Queensland, Australia

Dark quantum

From David J. Plews

I was pleasantly surprised by Michael Brooks's article on quantum gravity (3 January, p 26), and like all good articles it got me thinking. If photons, particles, atoms and so forth can exist in superpositions, interact with themselves and create two gravitational fields, would it not be possible to detect the extra mass?

And if so, what implications does this have in the context of dark matter and dark energy? Wath-upon-Deane, South Yorkshire, UK

■ The editor replies:

It's a great question, and one we don't know the answer to yet.

Space farming

From John Prewer

Michael Slezak writes that plants grown in space will need the soils we bring with us (20/27 December 2014, p 6). But why? In the Mars mission study programme in the early 1980s, NASA established that soil-less aeroponics was the best way to grow crops in space – mainly because it made large weight savings possible.

Bapchild, Kent, UK

Not quite everything

From Adrian Melott

The Theory of Everything is a well-acted biography of Stephen Hawking, which portrays scientists in a more realistic light than most films manage to do (3 January, p 40).

However, it severely minimises and distorts the role of Dennis Sciama, Hawking's doctoral supervisor. Sciama is portrayed as a cartoon character, a kind of

authoritarian gatekeeper who gradually develops affection for Hawking as he begins to regard him as a colleague.

Sciama was much more than that picture suggests, he was a superb mentor who brought out the best in his students. After Hawking's diagnosis when he spent some time depressed, Sciama said to him, "Well, you're not dead yet. So, are you ready to work on that problem I suggested?" The rest, as they say, is history.

It's my belief that Hawking's history could not have been the same without Sciama's constant interaction and feedback. I wish that his legacy had been strengthened by the film.

Lawrence, Kansas, US

Scientific language

From Martin Savage

Curtis Abraham's article on the importance of science to developing countries could also have mentioned the importance of English as the lingua franca of science (3 January, p 22).

In Thailand, where I live, very few academics and almost no students can read English, and this isolates them from developments in science outside their own country.

A few years ago a Bangkok academic attracted ridicule when he said that melting glaciers would not cause sea level rise in Thailand because there were no glaciers in Thailand. Greater promotion of fluency in a common language is an essential element of promoting science in developing countries.

Jomtien, Thailand

Hunger games

From Ken Pease

I enjoyed Brian Wansink's article describing how environmental tweaks can influence what is eaten, and in what amounts (10 January, p 36).

So I was disappointed that he did not cite the work of Stanley Schachter and his colleagues, who reached similar conclusions in their 1960s research.

Schachter remains a hero of mine because of the sense of fun evident in all his writings, and his genius for making simple observations carrying profound implications.

For example – how hungry did Jewish worshippers on fast days feel in the synagogue compared with when they stayed at home; and how was hunger influenced by clock time rather than the actual time elapsed since the previous meal.

Stockport, UK

Saturn skydive

From Galen Ives

Should I go rock climbing on the 6 kilometre peak of Saturn's moon Mimas (20/27 December 2014, p 58), I think I'll avoid the temptation to "simply leap off the top and float down to the surface", as Rebecca Boyle suggests.

Even though Mimas has only about half a per cent of Earth's gravity, a 6 km fall would be more



than enough space in which to reach lethal velocity.

Assuming a vertical drop, my descent would take a little over 7 minutes, plenty of time to take a last look at my surroundings before slamming into the crater floor at 98 kph.

Sheffield, UK

Counter conspiracy

From Lawrence D'Oliveiro

I have a game I like to play with those who believe in conspiracy theories (20/27 December 2014, p 36). The basic idea is that believers in one conspiracy tend to believe in others as well. You can point out the contradictions simply by running two conspiracies together, and asking them how they make sense of that.

Many of those who think the Apollo moon landings were faked also believe that in 1947, an alien spacecraft capable of crossing light years of space crashed at Roswell, New Mexico and is in the hands of the US government.

But surely if the government has access to such powerful, advanced technology, then taking a few men across to a little rock that is just a hop, skip and jump away would be mere child's play by comparison? The Roswell crash and faked Apollo missions can't both be true.

But then, that is precisely what the government would want you to believe, isn't it?

Dinsdale, Hamilton, New Zealand

Dangerous doses

From Donald Truman

In considering the possible health hazards of radioactive isotopes, it may be critically important to take into account the chemistry of the molecule in which the isotope is incorporated.

John Evans (3 January, p 55) reminds us that tritium is as explosive as hydrogen, and Harvey Rutt (20/27 December 2014, p 43) may have been happy to flush tritiated water out of the body with a few beers. But tritiated thymidine, which has been widely used in biological research, is incorporated into the nuclei of dividing cells and may persist in a location where it is most likely to be harmful.

Your correspondents rightly say tritium is not to be treated lightly. *Edinburgh, UK*

Domestic life

From Keith Bremner,

Tecumseh Fitch states that the brains of domesticated animals become smaller than those of their wild cousins (3 January, p 24).



In your Christmas quiz, you wrote that "Humans 10,000 years ago had brains that were 15 per cent larger than ours"

(20/27 December 2014, p 89).

Does this mean that we may have lost 15 per of our brains by domesticating ourselves?

Forest Lake, Queensland, Australia

■ The editor replies:

We may have. Anthropologists convened last year to discuss the idea that many features of modern humans can be attributed to a process of self-domestication, see: bit.ly/self-domestic.

Alien DNA

From Matt Black

Christopher Kemp's article on Maxim Makukov and Vladimir shCherbak's theories suggested that there are patterns in DNA's genetic code that could not have arisen randomly and so must have been planted there by alien life designers (20/27 December 2014, p 61). But DNA didn't just arise by random processes.

Although we don't know how, we surmise that the genetic code must have evolved from earlier self-replicating molecules.

Perhaps precursors of DNA

and the genetic code had self-replicatory properties but with fewer bases than four, fewer amino acids, or duplets instead of triplets.

The patterns we see may be the algorithmic fingerprint of that evolutionary process. However, if we fail to find plausible routes to support the idea that the code evolved, it would strengthen the alien code hypothesis.

Blockley, Gloucestershire, UK

Too much ear wax?

From Howard Bobry

I have, on occasion, accused friends, family and colleagues of having "selective hearing", but never to the degree attributed to Neanderthals in your Christmas quiz (20/27 December 2014, p 89).

You write that "there's no evidence they could hear sounds that no known animal can make." How sad that they never heard the roar of the ocean, or a clap of thunder.

Nehalem, Oregon, US

■ The editor replies:

We've docked 10 points from ourselves; we should have said "the ability to hear sounds of a pitch higher than any known animal can make", which is a quality of the greater wax moth, but not Neanderthals.

For the record

■ We had our wires crossed in the article on self-heating fabrics (3 January, p 15). It is a current – not a voltage – that is run through the cloth.

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NEWS reaches Feedback of a grim, cold first Monday back at university, and a class introducing humanities graduate students to statistics. Our informant was distracted by her neighbour snacking on McCoy's crisps – and especially by the prominent legend on the packet: “MAN CRISPS”.

Could this snack actually be deep-fried slices of man? If so, isn't there some sort of prior art claim from heirs of Mrs Lovett, proprietor of the pie shop supplied by demon barber Sweeney Todd? If the classmate wasn't munching on crispy fried slithers of male human, isn't there a trade descriptions issue here? And does the manufacturer have balancing plans for “woman crisps”, or “dolphin crisps” for that matter?

IN THE same vein as the above, it was purely for research purposes that Feedback purchased a packet that yelled at us that the chocolate buttons therein were “MAN SIZE”.

An image of a brown disc labelled “actual size” is accompanied by another image of a tape-measure, showing it to be 42 millimetres in diameter (and 5 millimetres thick) – shorter and more slender than most men.

Is there evidence that men are resistant to purchasing snacks unless encouraged by such confusing slogans? If so, research into health-promotion messages that take advantage of this must urgently be funded. “Real men don't get the munchies,” perhaps?

FED UP with advertising slogans that break the law, especially the laws of physics? Benjamin Careathers, David Wolf and Miguel Almaraz, a bunch of enterprising consumers in the US, were. On seeing the slogan “Red Bull gives you wings” they each thought “oh no it doesn't” and brought class action lawsuits against the makers of the energy drink.

As a result, if you are a resident of the US and bought one or more cans of the products in question in that country between 1 January 2002 and 3 October 2014, you can go to energydrinksettlement.com and claim a share of \$13 million.

In case you've forgotten since the settlement proposal was announced in October, Feedback reminds you that your deadline is 2 March, unless you want to object to the settlement or to opt out – which generally leaves you the option of suing separately – by 1 April. Lawyers may trouser \$4.75 million for negotiating the proposal, in which the manufacturers do not admit any wrongdoing or liability.

THIRST is best quenched with water. This is, we have observed recently, hard to find in the desert (25 October 2014). We reported Roger Riordan's recollection of hearing at school in 1944 that German scientists had invented dehydrated water, reconstituted with petrol.

Kristen McAteer reminded us how to get water from petrol. Her grandfather, who served in the war that was raging at the time, instructed her thus: suspend a small metal pail over a larger bucket. Fill the small pail with petrol, “being extremely careful not to allow the tiniest scrid to drip onto the outside or into the larger bucket”.

As the fuel evaporates and chills the pail, water condenses on the outside and drips down.

Richard Kerr mentions condensing the water formed when petrol is burned. Karen Page announces that she has “some dehydrated water on my dining table right now, next to the pepper. It used to be sea water.”

WE MAY have the origin of the above-mentioned story from Roger Riordan in a recollection by George Featherston. The 1960s British television series *All our Yesterdays* re-ran newsreels from the 1940s. George recalls one proclaiming “new British weapons”, including

an anti-searchlight to black out the moon, credited to “Professor Twerp, inventor of dehydrated water”.

FOR several months Feedback has suffered anxiety on seeing the phrase “veteran BBC DJ”. Now we venture to mention the case of one who lost his job in May 2014 after playing an 80-year-old recording of Ambrose & His Orchestra performing *The Sun Has Got his Hat On*, a novelty song with lyrics that unfortunately contain the racist “n word”.

The word can be heard more clearly in a version of the song recorded in 1932 by Syd Lipton and his Grosvenor House Band. This was restored for re-release in a series of CDs, *The Classic Years in Digital Stereo*, by Australian sound engineer Robert Parker. To get rid of the hissy background noise Parker captured noise from a “silent” passage and subtracted it from the music. The set was released on the BBC Records label.



FINALLY, lawyers in the energy drink case mentioned above may be planning a celebratory outing. They probably won't be taking the trip to Eastbourne, a seaside resort in the UK, advertised in the cutting that G. Izzard sends. The small print specifies: “All prices are based on 40+ passengers and two adults sharing a twin/double room.”

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week's and past Feedbacks can be seen on our website.

The UK Post Office is pushing life insurance – by email, to John Whittle, dated 16 December 2014, offering special terms if he applies before 10 January 2014

Scaredy cats

How do ultrasonic devices built to scare away animals such as cats work? Do they mimic a high-pitched sound known to scare such animals, or do they scare them simply by their loudness? Perhaps it is just that the sound annoys the animals as much as it annoys me.

■ These devices offer a modest deterrent effect – at best. A cat's personality and whatever it sees as its incentive for straying into a garden are likely to trump most attempts to keep it away.

A trial in suburban gardens suggests that these gadgets can cut the frequency of cat intrusions by about a fifth, and that those that do occur last a third less time. The combined effect is that cat traffic is halved.

Another trial, this time in the lab, introduced cats to the test area well beyond the device's stated range, with food arranged at 1-metre intervals from the device. Cats within earshot of it were less inclined to forage actively, but lingered longer than those at a distance. The only apparent sign of discomfort was an increase in ear-twitching.

Similar high-frequency devices built to deter loitering teenagers work on the premise that adults will be less affected, as they may have lost the ability to hear high-pitched sounds. Other products play classical music or whatever genre the makers deem unlikely to appeal to the average teenager.

There is an urban myth that

what has become known as the "brown note" can be used to disperse crowds. The idea is that people lose control of their bowels when exposed to sound at a frequency of around 5 to 10 Hertz, too low to hear but supposedly able to resonate in the body.

This myth seems to stem from research carried out as part of the US space programme. There were concerns about the stresses astronauts would experience at launch, so their physiological responses were tracked while they were strapped into their cockpit seats and subjected to mechanical vibration. The astronauts

"It's an urban myth that the 'brown note' - sound at 5 to 10 Hertz - can make you lose control of your bowels"

experienced serious bowel and other bodily discomfort because the vibration could reach their bodies via the seats. Air, in contrast, is poor at transferring low-frequency vibration as sound.

In cowboy films, characters may put an ear to railway tracks to "listen" for an approaching train, supposedly audible through vibrations travelling through the rails. In fact Hollywood is guilty of poetic licence because the vibrations can only be felt, not heard.

Needless to say, don't ever try this yourself, whether the railway is electrified or not.

*Mike Follows
Sutton Coldfield, West Midlands,
UK*

Smelly goat gruff

In the forest close to my house in Tuscany, there is a group of wild goats. When walking in the forest, I can smell their pungent odour many minutes before I see them, and they can be tens of metres away. Why are the goats so smelly? And if I can smell them from so far away with my relatively weak primate nose, can a wolf, lynx or another predator smell them from kilometres away?

■ It's male goats that are smelly, announcing to females that they are virile and have wonderful genes to pass on to offspring. The malodorous chemical cocktail originates from their urine and from scent glands near their horns. It is so potent that it can bring females into oestrous, or sexual receptiveness.

Japanese scientists put hats on male goats, trapped and analysed the stinking volatiles, and managed to isolate the most active constituent, 4-ethyloctanal. When female goats smelled this pheromone, it triggered ovulation.

For males, the reproductive imperative outweighs the risk of predators smelling them. And smelly goats do have ways of avoiding being eaten. They prefer to feed as a herd near steep rocks. Lots of eyes are on the lookout, and goats' eyesight is excellent,

"Male goats are smelly, announcing to females that they are virile, with wonderful genes"

augmented by having horizontal slits for pupils, an adaptation that improves peripheral vision. If one goat spots danger, the whole herd quickly climbs to craggy, safer slopes.

Archaeological and DNA evidence agree that the domestic goat (*Capra hircus*) was bred from the bezoar ibex (*Capra aegagrus*) 10,000 years ago by Neolithic farmers in the Middle East. If they escape, farmed goats quickly become feral, reverting to the behaviour and instincts of their wild ancestors.

*David Muir
Edinburgh, UK*

This week's question



FURLESS MIDRIFF

My Year 7 class left brine in evaporating dishes next to a sunny window. Several pupils ended up with dishes like the one pictured (above). We could explain the salt crystals at the bottom of the dish, but why is there no deposit around the middle of the dish when the rim is thickly furred with salt?

*Mr Holden and 7Y2
St Thomas More School
Crewe, Cheshire, UK*

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